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NATIVE ARTS AND INDUSTRIES ON THE ARCHER, KENDALL AND HOLROYD RIVERS, CAPE YORK PENINSULA, NORTH QUEENSLAND

By URSULA H. McCONNEL, Eagle Heights, Queensland.

Plates i-xvii and text figs. 1-4.

SUMMARY.

This paper describes in technical detail material collected during field research in 1927, 1928 and 1934 in the Gulf of Carpentaria region of Cape York Peninsula, North Queensland, and particularly on the Kendall, Holroyd and Archer Rivers, which is housed in the South Australian Museum. This material is complementary to that obtained by Hale and Tindale (1933) on the east coast of the Peninsula and demonstrates Papuan and Torres Straits Island influences upon mainland culture.

The specimens, which are fully listed and illustrated in plates and drawings, are described in relation to the cultural background to which they belong.

INTRODUCTION.

The material described in this paper was obtained by means of grants from the Australian National Research Council in 1927-28 and 1934, since when I have been awaiting an opportunity to prepare it for publication, an opportunity recently afforded by courtesy of the Director of the South Australian Museum, in which institution it is now housed and where I have had the assistance of members of the staff in sorting, repairing, describing and photographing the specimens shown in these plates. I am particularly indebted to Mr. Norman B. Tindale for his help in classifying and describing specimens; the technical descriptions of which are largely his. The compilation of the material has been further assisted by a grant made towards typing costs by the Science and Endowment Fund of the Council for Scientific and Industrial Research Organisation, which I gratefully acknowledge here. I would also like to acknowledge the assistance of the late Government Botanist, Mr. Cyril White, in identifying plants referred to, and to Mr. B. C. Cotton for identifying shells. I am also indebted to my brother, Mr. K. H. McConnel, F.R.I.A., for the drawings of text

figures, and to Miss M. Boyce for the preparation of the ethnographical photographs.

My task as a social anthropologist is to place these artefacts in their social setting and to describe their function in the way of life to which they belong. This way of life may have existed for thousands of years and would still be existing indefinitely if it had not been disturbed.

The specimens are all from Cape York Peninsula, North Queensland, and, unless otherwise stated, from the Archer, Kendall and Holroyd Rivers, which flow into the Gulf of Carpentaria on the Queensland side. The area in question forms part of a Native Reserve extending along the Gulf coast from the Batavia to the Mitchell River. A list of specimens is appended, fully illustrated by plates and drawings, together with their registration numbers in the South Australian Museum. Native names of specimens, unless otherwise stated, are given in the Wikmuŋkan language. The phonetics of the Wikmuŋkan language are as outlined in my previous paper (McConnel 1945). *S* in *Sivri* is a northern sound, not used in the Wikmuŋkan language; *l* is sometimes a cerebral *ḷ* not previously recorded, but usually a palatal; *r* is sometimes a retroflex palatal *ṛ* and *t* is sometimes an interdental *ṯ*.

I am indebted to Prof. A. P. Elkin and the Australian National Research Council for arranging the use of a special symbol used in setting up one of the native words given herein.

Archer, Kendall and Holroyd Rivers area is sheltered from northern contacts by the mangrove-clad and crocodile-infested Archer River (five miles wide at the mouth), and from the eastern coast by the Great Dividing Range. It is low-lying country, perfectly flat for thirty to forty miles inland, and inaccessible to stock on account of its innumerable water channels, its net-work of lagoons, swamps and water holes, with bogs in all directions. As it teems with wild life, it is a veritable paradise for its native inhabitants.

I chose this field for research because nowhere else in Queensland was I likely to find a native culture less disturbed. In 1927 I accompanied the Aurukun (Archer River) Mission's first journey overland into these parts, which had at that time been but partially surveyed. Apart from a few sandal wood-getters, and a visit by the Mission lugger, little other white contact had been made, though some of the men had visited the Mission the previous year, and some had signed-on for work on pearling luggers. Here the natives pursued their customary life oblivious of an outside world. John Burke's steamer, on its monthly voyage down the Gulf to Normanton, was regarded as a corpse in the course of cremation—inspiring, appropriately enough, a funeral dirge.

INFLUENCE OF PAPUA AND ISLANDS OFF CAPE YORK ON THE MAINLAND CULTURE

In studying the culture of the Peninsula in general, one has to take into consideration the proximity of the mainland to Papua and the Torres Straits Islands. Contact undoubtedly has been made, over a long period, apparently by means of the double out-rigger canoe, which is made and used by Papuans, Islanders and mainlanders alike, as far south as Princess Charlotte Bay (Stewart River) on the east coast, and the Batavia and Archer Rivers on the Gulf Coast. Haddon and Hornell (1937) have made a detailed study of the canoes in this area. Haddon (1912) speaks of these canoes as voyaging to the mainland from the Islands in 1888 and demonstrates the similarity of Island customs and artefacts to those of the Papuan mainland. It is not surprising, therefore, to find cultural similarities existing also between the Islands and the Cape York mainland, particularly where direct contact by canoe has been made. Owing to the early establishment of a Government Resident at Somerset, near Cape York, however, there is little evidence left of such contact in the area nearest the Islands, where it must have been most obvious at one time. Evidence of this cultural contact diminishes inland and southwards as direct links by canoe recedes, borrowed customs being adapted and simplified to meet mainland requirements and the conditions of a hunting rather than a village life. This external influence extends further south on the eastern coast than on the western Gulf coast, because the eastern coast is more accessible by canoe. This eastern coastline of the Peninsula, and particularly the Princess Charlotte Bay region, has been studied and recorded in detail by Hale and Tindale (1933). They also discuss the use of double and single out-rigger canoes.

In this area of direct contact on the east coast, Thomson (1933, 1934) describes the use by the *Koko Ya:'o* (Pascoe River, Princess Charlotte Bay) of drums, bark-strip skirts, masks and dance enclosures in the cult of the crocodile. These were reported also by Roth (1909) in the Margaret Bay area and occur also in the dances of the sea-eagle, sea-gull and Torres Straits pigeon cults of the *Tyɔ'ŋandyi* and *Yu:pŋati* tribes, south of the Batavia River on the Gulf Coast, as do also the drum and the bow and arrow, recorded by Thomson (1934) and by McConnel (1936), but which are not found elsewhere on the mainland and are typically Torres Straits Islands and Papuan. *Sivri*, the seagull, is said to have made his drum of two kinds of wood, the hollow stem of the pandanus tree for soft sounds, and messmate wood for loud sounds, and to have covered both ends with goanna skin. The specimen shown here in Plate vii, fig. a, has only one end closed, a type which is also found in Papua. The palm of the hand is used for low sounds and the fingers for high sounds. *Sivri* is also said

to have made his bow from the wood of a native shrub and its string from the fibre of the bean tree root.

It is in the totemic pattern of the mainland that these sea-going heroes should be said to have voyaged, in the direction of the migratory birds they respectively represent, to Maubiag Island and the Papuan mainland, and, on returning thence, to have introduced these arts to the mainland. The song and dance of the seagull and Torres Straits pigeon resemble those used in the Islands and Papua, and the Maubiag cult is regarded as a brother-cult to that of *Sivri* on the mainland.

These objects are not in daily use, however, and occur only in the ceremonial dances. In addition to such objects found only in these dances and common also to Papua and the Islands, are the plaited pandanus palmleaf armlets, pearl-shell pendants, cowrie and pearl-shell necklets and head bands, nautilus shell nosepegs, large wooden ear-cylinders (worn suspended in the ear-lobe which has been pierced (Plate i, fig. a) and gradually stretched for the purpose), and ornamental clubs, all of which are either traded-in or copied, and are in use to some extent all over the northern part of the Peninsula.

Customs shared with the Islands and Papua which have permeated the common life of the mainlanders are (a) the use of the sleeping platform, which is sometimes two-storied like those shown in use on the Islands by Wilkin and Haddon (1912) and Roth (1910); (b) the round bark-house which is also shown by Wilkin and Haddon (1912) in use on the Islands; (c) the Papuan communal pipe, made of bamboo or hollow wood (Gulf area), sealed at both ends with wax, with holes on the top at either end used respectively for holding the cigarette and for inhalation. This is a pipe which can be passed around, with a finger over the smoke-hole, and shared when tobacco is scarce; (d) the weaving of baskets from *Xerotes multiflora* as described by Haddon (1912), and most striking of all, perhaps, (e) the practice of mummification, described by Roth (1907), with its attendant mourning restrictions and observances, its mourning dance or wake, and its concluding feast and wrestling match—though these rites are far less elaborate and spectacular on the mainland than those described for Papua and the Torres Straits Islands by Haddon (1912) and Harris (1912) and end in cremation.

Tyi:t, the fishhawk, a hero of the *Ndra:'aŋit* tribe (north of the Archer River), is said to have introduced these funeral rites in honour of his brother *Mbu:,* the ghost, who was killed fighting (Plate vi, fig. c, e and f). According to the legend, recorded by McConnel (1935), this hero, after removing the intestines and liver, etc., through an opening made in the side, tied the body

of *Mbu:* to a long pole and suspended it on two forked sticks to dry near a fire. Then the body was rolled in ti-tree bark (Plate vi, fig. e-f), tied round with bush string and carried to his parents, and a big dance was held. The corpse is kept thus on forked sticks for the required period, i.e. for anything up to two or three years according to the wishes of the relatives, and is guarded always by them in a secluded spot, the wake being periodically performed by the women, if and when the corpse is in camp. These rites have already been described by McConnel (1936). Relatives of the opposite moiety are subjected to food obligations and speech taboos, especially the widow, who has to sit and weep, and eats only when given certain foods by the deceased's relatives, to whom she may not speak. She must remain apart from the camp, her head covered with ashes and tufts of hair fastened with beeswax over her head. Mourning ends with the cremation of the body at dawn after an all-night vigil kept by women in relays accompanied by a continuous wailing and performance of the mourning dance. The cremation is followed by a feast, when the recognized food debts are paid, and a wrestling match takes place (between members of the same moiety only), after which the widow's head is shaved, her remarriage arranged, and all food and speech taboos are lifted. I witnessed a cremation on the Archer River in 1927, which was probably the last to be performed near the Mission there. These practices then extended as far south as the Edward River, and probably even further along the Gulf Coast. Along the east coast the type of mummification varies. Harris (1912) and Roth (1907) have described the various forms found as far south as southern Queensland. A legend of the *Ka:ndyu* (near Coen) reported by McConnel (1937) shows that burial also was practised on the Peninsula. Roth (1907, p. 399) reports the eating of the deceased's flesh by the widow, a custom also recorded for the Torres Straits Islands. I myself have nothing to report of this nature in the Gulf area; but in the Mossman-Daintree area on the east coast an informant had eaten a part of the thigh of his sister, and expected thereby to become better at finding yams, in which art she had excelled. The eating of certain parts of a dead relative's flesh was an accepted duty that one should honour if not enjoy. Roth (1907) records the carrying of the deceased's bones by certain relatives. This custom was still practised south of the Archer River in 1927-28; the carrying of the leg bones was said to be a means of preventing the deceased's ghost from walking about the camp after death. Hale and Tindale (1933, p. 94) describe similar burial customs at Princess Charlotte Bay on the east coast.

In contrast to these Island and Papuan affinities, it is interesting to note the absence on the Peninsula of the boomerang and shield, so typical of the

south. The use of the former is, however, recorded in a *Wik-kalkan* tribe legend as having been used to clear scrub. The boomerang can be made, but it is not now used. The shield is used on the Mitchell River to the south. It assumes unusual proportions on the east coast in the Cairns-Port Douglas region in association with the large wooden fighting sword, peculiar to these parts (see McConnel 1935, 1). Absent also from this part of the Peninsula are the rite of circumcision and the four-section system; according to Tindale (1940) the former does not occur east of Burketown and the latter occurs only to the south of Princess Charlotte Bay.

FOOD SUPPLIES AND ECONOMIC PURSUITS.

The Gulf Coast is rich in food supplies—in animal, bird, fish and plant life. The sea yields dugong, sea-turtle and large salt-water fish for those who own an outrigger canoe. The tidal rivers bring in a plentiful supply of fish with every incoming tide, which men spear from the prow of the indigenous bark canoe. Fish are cooked in the coals. Stingray, a delicacy reserved for older men, is flavoured by rolling the cooked flesh around the previously removed heart and liver, wrapping all in ti-tree bark and cooking in an antbed oven. The sandbeach supplies crabs, sea-turtles' eggs and shellfish of many kinds, which the women gather at low tide and cook in the coals (the heat opening the shell). Oysters cluster thickly on the roots of the mangrove trees edging the mouths of certain salt-water creeks (Plate i, fig. c). In the salt-water creeks women collect mud-mussels *(Gelonia coaxma),* crawling along the creek bed on all fours as they feel for the shells with their fingers in the mud, dropping them into dillybags suspended from the neck or held in the teeth. River beds and fresh-water channels inland are interspersed with deep water-holes (left after flooding). These harbour fish and the fresh-water crocodile, the eggs of which are dug out of the sand and eaten as a delicacy, especially when nearly hatched. The freshwater turtle is cooked upside down in the ashes; then, after knocking out the under-shell and removing the head and limbs, the shell is used as a soup toureen; juices from the body make a soup which is imbibed by dipping a frayed end of a stick into the juices and sucking it. The eggs are sometimes fried in the juices of the up-turned shell. The salt-water turtle's eggs, which are soft-shelled and do not set when cooked, are usually sucked raw.

Swamps, lagoons and waterholes are the haunts of wild fowl—duck, geese, ibis, native companion, jabiru, etc. Emu are to be found in certain localities inland, and flying-fox camps are numerous in mangrove and other scrubs. Kangaroo (inland) and wallaby abound. Men spear all these by stealing up

close, merging with their surroundings and disguising themselves with branches in open country.

In the dry winter months, the grass is burned off and kangaroo and wallaby are speared as they flee before the flames. Women follow in the wake of the flames, digging out from the holes, in which they have taken refuge, bushrat and bandicoot, iguana, snakes and lizards, etc., with the aid of their yamsticks and the domesticated dingo. All these foods are cooked in antbed, as are emu and all large birds and animals, the skin and viscera being discarded only after cooking.

The antbed oven is made by digging a hole in the ground, lighting a fire in it and heating chunks of antbed in the fire. When hot, the fire is removed and the food then placed between the pieces of hot antbed and covered over with clean strips of ti-tree bark, over which the sand or earth is piled to preserve the heat. This method of cooking is that of a slow oven and preserves all the juices in the meat.

Swamps near the coast are filled with rushes *(Scirpus littoralis)*, the corms of which are dug out by the women, sitting up to the chest in mud around the edges. The corms are carried home and washed and roasted in the coals, the old ones being first beaten with a wooden hammer into a flat cake. Corms of the up-river swamp rush, called "bush-nuts," which are washed up with the flood rubbish in the wet season, are also cooked and eaten. The seeds of the mangrove pod are cooked and ground into flour.

Swamps and lagoons are covered with white and blue water lilies of several varieties, the flowers and stalks of which are eaten raw, the roots cooked in antbed and the seed-pods roasted in the coals. The women wade in the lagoons and swamps for these, and dive for the roots in deep water. Yams of several varieties, arrowroot and many other roots are dug up by the women with their yamsticks. Sometimes the top of the yam is left adhering to the stem of the vine and replanted, only the lower part of the root being taken for food, which is interesting where agriculture is unknown. A similar practice is reported by Hale and Tindale (1933, p. 113) on the east coast. Edible fruits of many kinds are gathered in the summer months. As they travel through the bush, especially in spring and summer, the eyes of all are on the look-out for the tell-tale bee, coming in and out of its hole in tree or log. The shading of the eyes with the hand, looking upwards this way and that as they travel, is so characteristic an attitude, that it is used in corroboree to signify a journey through the bush. When a bee is sighted, the tree is felled, or climbed, and a stick with a frayed end is inserted into the hole to test the supply of honey. When found to be

present, it is chopped out and eaten—bees, wax and all—till the spoilers are replete. The surplus is carried home tied up in bark or in a tubular "grass" basket (woven closely for the purpose) and is usually mixed with water to make a sweet drink. There are a variety of honeys, taken by bees from different trees and shrubs, each with its peculiar flavour and its special name. As it is the woman's place to supply roots and small game obtained by digging, the yamstick is regarded as the symbol of womanhood; and since it is the man's part to provide meat, the spear is the symbol of manhood. In ceremonies the part of a woman played by a man is always signified by the use of a yamstick.

MATERIALS AND TECHNICAL EQUIPMENT.

The equipment required for these economic pursuits is limited by the materials available. As previously stated, stone and flint are lacking in this area. Axes and knives are traded in and are a rare and valuable possession. Spear barbs are made from the bones of stingray, emu, kangaroo and wallaby—the jawbone of the latter being used as a craper and, with the incisor attached, as an engraver. Wallaby bone is used also as a stiletto for piercing holes in bark, etc. Such material takes the place of flint in other places. Shells (particularly the mussel-shell) are used as scrapers and as spoons. Sharp fragments of shell-grit, hardened by the action of the sea, are used for grinding and shaping the edges of pearlshell, and the spiral shell *(Turritella cerea)* is used for boring holes in the shell discs thus shaped. The bailer shell *(Melo amphorus)* is used to bail water out of canoes and wells, as a drinking vessel, and for heating gum, etc., on the fire.

The plentiful supply of hardwood and softwood timbers (and bamboo), with their stems, bark, gums and fibres, supplies the greater part of the material used in the manufacture of artefacts. Yellow stains are obtainable from certain roots, and red and white clays and charcoal are used as colouring matter. Beeswax is used in addition to gums for sealing purposes. Grass bugles, scarlet seeds and yellow orchid bark, feathers and cowrie shells (threaded on string) are used for decorative purposes.

During the dry winter months people sleep by the open campfire, wherever food supplies take them, by lagoon or swamp, riverbed or seashore, and on recognized camping grounds used from season to season. Break-winds of bark and branches are placed against stakes in the ground as open shelters, the branches also affording a shade during the heat of the day. Camps consist usually of small family groups, but where the food supply is temporarily abundant, as by water lily lagoons or swamps (Plate ii, fig. d, and Plate iii, fig. a-b), at certain

times of the year, larger groups assemble and an opportunity is afforded for holding initiation ceremonies and inter-tribal discussions, etc. During the wet north-west monsoon season in the summer months, however, when rain is incessant and flooding takes place, it is necessary to build more permanent shelters. A common shelter used is the sleeping platform, built mostly near inland water holes and water-courses, which attract birds, and where wallaby may be speared and fish trapped. The sleeping-platform is made by placing saplings on four forked sticks and laying others across them, which may then be covered with sheets of messmate bark. Under this platform fires may be lit for cooking, which also provide a smokescreen to ward off mosquitoes. Sometimes a second story is built to form a ceiling above the first. When the weather is squally, especially near the coast, a completely covered-in bark house is used. The round beehive-shaped bark house is made of branches placed circularly in the ground and tied at the top, over which strips of ti-tree bark *(Melaleuca leucadendron)* are laid so as to completely cover over the branches, one piece being removed when going in or out. Inside these sealed bark houses, with a fire smouldering, a family with its dogs may live snug and dry and free from mosquitoes till the worst weather is over. These houses and platforms, being used only during the wet season, usually fall to pieces from neglect during the winter months. In a hunting community, where there is no incentive to build permanent houses as in the case of the village settlements of the Torres Straits Islands and Papua, there is no adequate storage for goods made from perishable materials. Perhaps for this reason mainland artefacts are less elaborate and spectacular than those of Papua and the Islands, though the technical skill and artistic finish of the former are none the less excellent, and adequate for the requirements of their owners.

The double out-rigger canoe is fashioned from the trunk of a milkwood tree. The out-rigger booms pass over the gunwale and are fastened, inside and outside the hull, by strips of green bark (usually *Hibiscus*) to a stick which passes through both sides of the gunwale. In the specimen I saw made on the Archer River, the two booms were not made in a single piece, but in two pieces, and were fastened to the floats on either side by lashing. The dug-out canoe can travel along the coast and out to sea in calm weather and is used for fishing expeditions. The art of making out-rigger canoes on the Archer River was possibly copied from the Batavia and Embley River Missions in the north and may have deteriorated. Certain it is, however, that the out-rigger canoe is not an indigenous product and must have been introduced at some time or another in the past to the mainland. The mainland canoe is made from bark of the messmate tree (*vide* Haddon and Hornell, 1937). After ringbarking a strip of bark

of the required size, the bark is smoked dry over the fire. It is then folded in two (inside out) and placed between two sticks to secure it (Plate i, fig. b), whilst each end is shaped by cutting off a triangular piece downward to the fold. The ends of the canoe are secured by sewing-up these shaped ends with a piece of cane, the point of which has been sharpened and hardened in the fire and the cane softened by biting. The cane is passed through holes pierced in the bark (Plate i, fig. b) by means of a bone stiletto (with or without a wax knob to protect the hand). When both ends are thus secured, the canoe sides are drawn together to the required distance by tying strips of green hibiscus bark across the canoe towards prow and stern, and the canoe is kept open by two forked sticks placed crosswise under each tie. The inside of the canoe is sealed with beeswax to render it watertight. A young mangrove stem splayed at the end is used as a paddle. To manipulate the canoe, the rower kneels, or sits on the floor with his legs out in front of him, and swings the paddle first to one side and then the other, which also serves to steer the canoe. The sides of the canoe are sometimes only a few inches above water level. The canoe is so light that it responds to the slightest movement of the paddle (Plate i, fig. d), and the paddler must maintain a perfect balance if he is to escape the crocodiles lurking below. When hunting, the fisherman stands in the prow of the canoe, spear poised on spear thrower, alert for action. When hunting the bony bream at night time he holds a bark torch in the one hand, which attracts and bewilders the fish. As the fish flashes past, the spear flies through the air, and the fish, plunging madly, carries the spear with it, till, the paddler deftly steering the canoe in chase, the fish is captured and the spear retrieved.

Messmate bark is also used to make vessels for carrying and washing food and as a baby's cradle (Plate iv, fig. d). The bark is treated as for canoes, but instead of cutting and sewing up the ends, the bark is thinned out at the ends and gathered together with pleats held by a wooden skewer, which is bound over and over with coarse bark strips to secure the pleats.

Spears naturally vary in make and type according to the use for which they are required (Plate viii). Short spears are used for fighting (or hunting wallaby) at a distance. The heavy spears are used for large game such as kangaroo, wallaby and emu, etc., and the lighter spears for fish and birds. Heavy spear shafts are made from the straight young stems of ironwood or acacia, carefully scraped and shaped to the required balance, the light part being used near the throwing-end and the heavy part near the head and barbs to throw the weight forwards. Light spear handles are similarly made from lighter woods such as rosella, hibiscus, cottonwood, grass-tree flower spike, and bamboo, etc.

A spear may be made all in one piece, or with a separate butt or head, or with both. Sometimes an imitation butt or head is simulated by painting the part with clay. A spear may have one, three or four points, which are usually made of acacia wood. The barb is fastened to the point with wallaby or kangaroo tail sinew and is covered over with grass-tree (or other) gum heated over the fire in a bailer shell and smoothed on a wooden palette, which is sometimes fitted with a wallaby incisor for engraving (Plate ii, fig. b).

Stingray-bone barbs are used for fighting and punitive spears, and are very poisonous. These barbs may be arranged serially along the head, pointing backwards or in a cluster of three, or in a flower-like cluster (painted red) on a stem-like head (painted white). Ceremonial spears are decorated with white and red clay in large or small circles. Sometimes blood is smeared along the shaft of a spear in a wavy pattern (made by turning the spear in a blood-stained hand), used possibly as a charm to acquire power in hunting another victim.

The spearthrower of the Peninsula is distinctive with its shell ornament at one end. The shaft, which varies in width, has a smooth, plain surface contracting towards the head-end, and is plastered at this end with gum, which serves to fasten to this end twin bailer shell discs, against which the spear is balanced. In use, a wooden peg at the other end engages the end of the spear. The shaft is sometimes ornamented at the end with bands of yellow orchid bark and scarlet *Abrus* seeds are sometimes let into the gum of the shell ornament. Children use toy spears 50″-53″ long, with wooden points let into light cane shafts lashed with bark fibre (Plate ii, fig. c). On some of these a strip of bark is left in a position similar to that used by poisonous gum on adult spears so as to make believe it is a fighting spear, and sometimes string round the handle is used to simulate a join between head and shaft, also in imitation of an adult's spear (Plate ix, fig. g-k).

Shields are lacking, but wooden clubs with painted knobs or plain flat sticks are used to deflect spears (Plate x, fig. b-e). Women use long hardwood fighting sticks usually made of acacia wood and painted red with white points, and are supported by "seconds" in a fight, who use short sticks, similarly painted, to hit back the opponents' spears (Plate ix, fig. c-f). Axes, which are traded in, and the beater, the yam-stick and the fighting-stick used by the women are made or hafted in hardwood.

Gulf firesticks are made of matchbox-bean wood and are as long as spears. For carrying, the two sticks are fitted into a double-barrel sheath, made of two hollow bamboo tubes tied round with strips of yellow orchid-bark and fastened into a knob of beeswax studded with scarlet *Abrus* seeds. These

sheaths with their colours of fire add a gay note to the camp scene. To kindle fire, one stick is laid on the ground and steadied with the foot, whilst the other is twisted between the hands with a swift downward movement, and creates the required friction as it rubs against the stick on the ground. As soon as a spark is kindled, it is deftly dropped into tinder, and is blown between cupped hands into a flame for starting the fire. When no firestick is to hand, a smouldering stick is carried and rekindled at intervals by stopping to make a small fire; a piece of bark is often carried for kindling purposes. The wings of such large birds as jabiru, ibis and native companion are fastened together (stretched out and stiffened) to form a feather fan which is used as a bellows and is carried about on a string-loop passed over the wrist.

The soft bark of the *Melaleuca* is used for innumerable purposes. Apart from its use for walls of houses, breakwinds and shelters, it is used to wrap up objects of all kinds and sizes, from corpses to spearbarbs and clays, and for covering food when cooking in antbed ovens, etc. Twisted into a flat pad, it is worn by women to distribute the weight of loads carried on the head, such as a bark vessel loaded with roots or a pile of firewood picked up on the homeward journey. As a small wedge it is used to break the strain of string handles on "grass" baskets. Women use a strip of ti-tree bark for utility purposes (Plate xi, fig. q), which is passed between the legs and fastened back and front to a waist-string by turning in the ends. Rolled into a long bundle, this paper bark serves as a torch or flare at night-time (Plate xi, fig. r).

Strips of green bark (usually *Hibiscus*) are used in the rough for binding purposes, e.g., in making canoes, houses and bark vessels, etc. Fibres are used in making rope and twine for weaving fishing nets, dillybags, aprons and decorative strings, etc. The coarse red fibre of *Acacia flavescens* or *A. latifolia* makes a strong harsh string *(koi pɔ:la)* for fishing nets, etc., whilst the raffia-like strands of the under epidermis of the *Livistona australis* palm-leaf makes a firm white string *(koi tu:ʈa)* for more delicate use. The fibre most commonly used for making twine for dillybags, aprons, etc., is *Ficus cunninghamii (koi ŋa:tan)* (Plate xi, fig. b). The fibre is softened by soaking it in water or chewing it in the mouth. When dry it is stripped into strands and tucked away in a bundle ready for use (Plate xi, fig. a). Twine is made by twisting together strands (usually two) of the required size with a deft movement of the palm of the hand against the thigh, which is used as a kind of table, i.e., with the lower leg and foot tucked under and the other leg crooked up out of the way. Roth (1901, Plate ii) illustrates this method of making twine, and in other plates in this same Bulletin fully illustrates the various types of

weaving and netting used also in this area and shown in the accompanying drawings. "Grass" baskets *(kămpian)* are made (Plate iii, fig. c-d) from the blades of *Xerotes multiflora*. They are usually made wide at the mouth (Text fig. 1c), but also woven closely in tubular form for holding honey (Text fig. 1b) and, in smaller sizes, as tobacco pouches for the men. Sometimes the basket is close-woven at the base only, to hold food when washing it, allowing the water to escape through the more open weaving of the sides. These "grass" baskets are woven in an anti-clockwise chain-twist pattern (*vide* Roth 1910, Plate xvi), and are woven over basal strands from the bottom upwards, the ends being turned in at the top and sometimes over-wound to make a neat edge (Text fig. 1c).

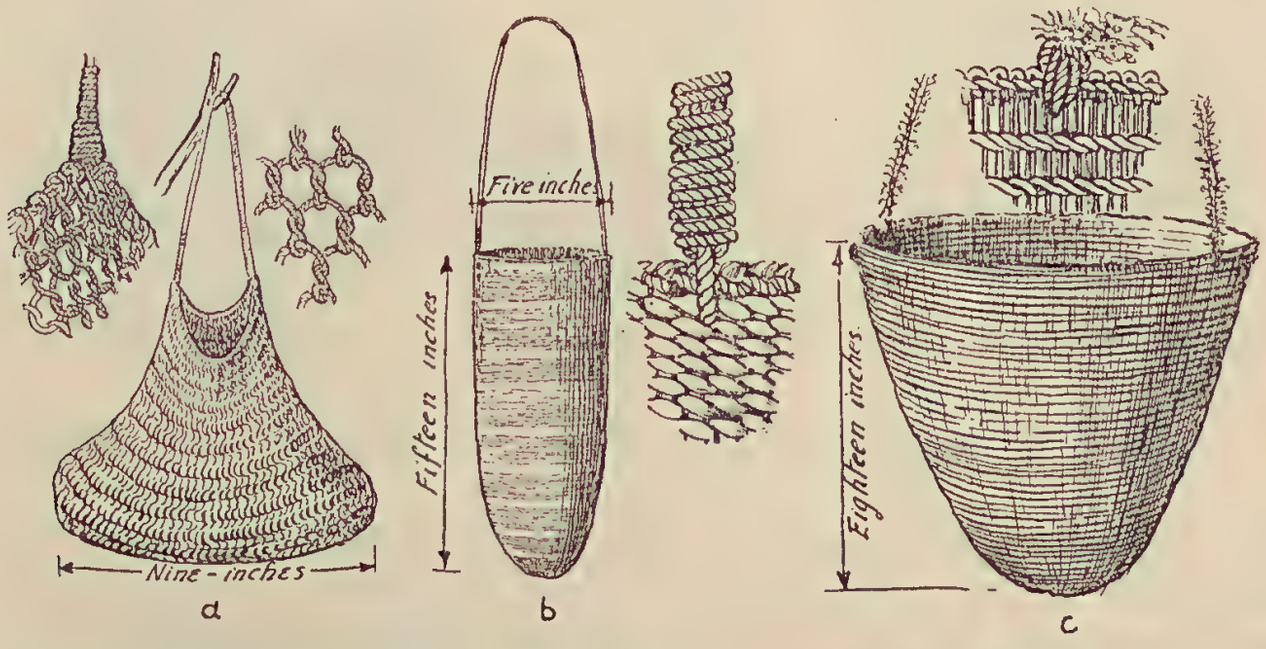

Fig. 1. Bags and baskets. a. Dilly-bag in the hour-glass pattern. b. Closely woven basket for holding honey. c. Wide-mouthed basket made with anti-clockwise chain twist.

Dillybags *(wa:ŋka)* are sometimes made in this chain-twist or "grass"-stitch pattern (Text fig. 2c-d) from the *Livistona* twine *(wa:ŋk iyampan)* and sometimes in the fishing-net pattern *(wa:ŋk o:nyana)* (Text fig. 2a-b). Most dillybags, however, are made (Plate iv, fig. c) in the hourglass (usually double-loop) pattern, from brown fibres of the *Ficus (wa:ŋka ŋa:tan)*, red *Acacia (wa:ŋka po:la)* and white *Livistona (wa:ŋka me:'a)*, and often two or more of these twines are combined to give a striped effect. The hourglass stitch is worked with one continuous long strand (joined at intervals) for the whole length of the dillybag, from a basal strand stretched between two sticks (Plate iv, fig. c), or from one big toe to the other (Roth 1901, Plate viii-x).

Fishing nets are usually made in the fish-net pattern (Roth 1901, Plate xi), but the specimen shown (Plate xii, fig. a) is made in the hour-glass pattern, the

strands being looped around a basal cane withy (bent to form a hoop) and lashed over with strands of strong *Hibiscus* bark (Roth 1901, Plate x, fig. 4-5). The technique then proceeds as with dillybag making. The looping commences at the top (over the hoop) and gradually narrows towards the bottom, which is abruptly finished off with a flat intermeshing (knotted at the final end), thus giving a wide, flat base to the net.

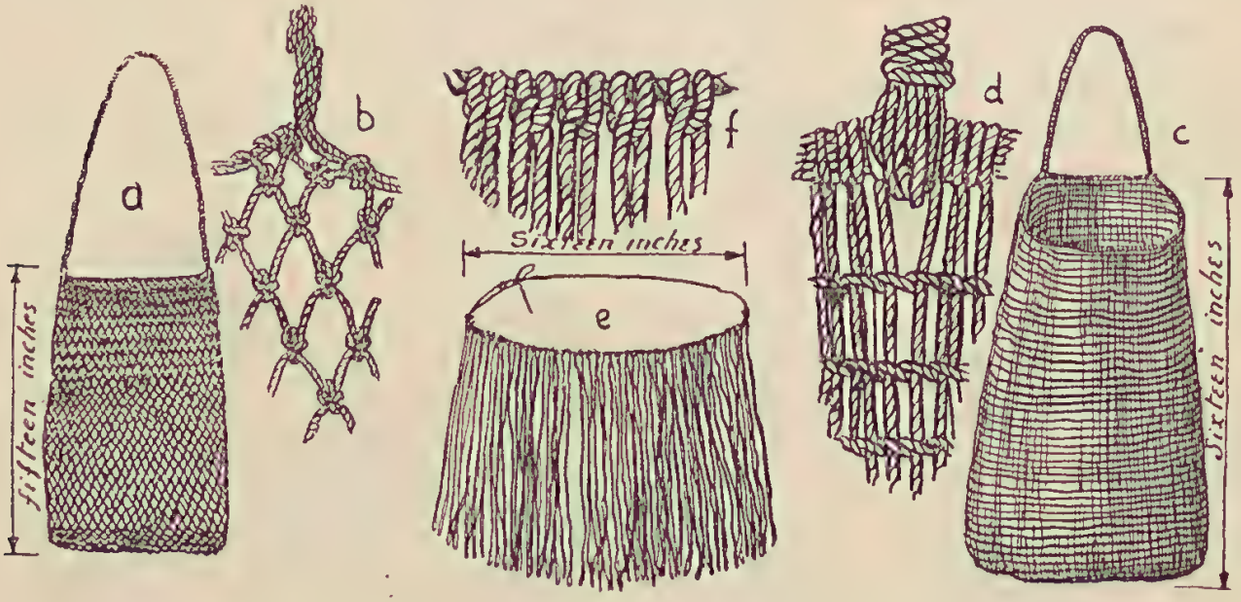

Fig. 2. a. Netted string bag. b. *Ditto* detail. c. Coiled string bag. d. *Ditto* detail. e. Woman's apron. f. *Ditto* detail.

The type of handle used with "grass" baskets and dillybags varies. These may be of one or more strands used separately or overwound to give strength (Roth 1901, Plate vii, fig. 7). The method of fastening also varies; e.g., the basal strands may be caught together with other weaving strands to make a central core which is overwound, or separate strands may be passed directly through the basal strings on either side, overwound, and fastened in the centre by knotting or intertwining. Sometimes the handles are fastened more to one side of the mouth, so that the mouth falls open when in use (Text fig. 1a), allowing the hand to pass in and out easily and the dillybag to lie flat on the back. The handle is sometimes interwoven with jabiru-down to make it soft against the forehead. Handles of "grass" baskets are usually fastened to the sides with a protective wedge of bark to break the strain of the handle on the basket, or a small stick may be used, which is more easily removed and renders the handle detachable.

Women's aprons *(wa:ta)*, may be made from *Ficus*, *Acacia* or *Livistona* twine, but usually from *Ficus* which is softer, and may be coloured with red clay or stained yellow with the root or leaves of *Alphistona crotonoides* or

Morinda citrifolia, which is used also for cleaning aprons and dillybags, when the colour is usually rubbed off afterwards. Aprons are made on a basal waist-string (Text fig. 2e-f) from which long loops of equal length are suspended in front and fastened by a single loop to the waist-string (Roth, 1901, Plate vii, fig. 4). The basal waist-string is looped at one end and the ends left free at the other end for tying into the loop. When not in use, this apron is rolled round a stick and fastened round with the loose ends of the waist-string, leaving the loop at the top for carrying.

RITUAL AND DECORATIVE ART.

Clothes in the European sense are non-existent. Men and women go naked. Aprons are worn by women only on certain occasions with a special significance. A young girl *(kɔman manya)* first wears an apron when she returns to camp after separation at the onset of puberty, and after each ensuing separation for a similar reason, either as a mature girl *(kɔman)* or as a married woman *(wantya pi:'an)*. When a mother returns to her husband's camp at the end of her isolation during childbirth, she wears a brand new apron, bringing with her an offering of yams and fish, one dillybagful each for herself and her husband and one from the child to its father. Aprons are also worn by women on ceremonial occasions, as when they take part in dances, and especially for the mourning dance.

As healing, power-giving and protective charms, plain strings are tied round the affected part, for headaches, pains in leg and stomach and sickness. Men wear strings round arm or leg when hunting, and pregnant women wear them around the abdomen when diving for water lilies. Decorative strings are worn on ceremonial occasions. Both men and women wear shell nosepegs (made from *Megalotractus aruana*), pearlshell pendants suspended from a string round the neck. Such necklets and headbands of threaded discs are made of pearlshell and *Nautilus pompilius*. Men wear pandanus-palm armlets, plain and plaited (Roth 1901, Plate iv), a large hollow wooden ear-cylinder (painted red and white and worn in the lobe of one ear, which is stretched to hold it), or, less usual, a collar of light wood covered with beeswax and studded with scarlet *Abrus* seeds. Women wear cowrie shell girdles and cross-overs. These ornaments are mostly borrowed from the north and are not, properly speaking, indigenous. Indigenous art is seen in plain and over-wound strings, strings interwoven with possum-fur and jabiru-feather down, threaded golden grass-bugles (Text fig. 3c), plaited yellow orchid-bark, local pearlshell necklets and headbands, and nowadays (when needle and cotton are available) strings of scarlet *Abrus* seeds.

Women's strings may be made completely circular for passing over the head, either of the required size or long enough to be doubled and redoubled a number of times; or they may be made of one or more strings fastened together at the ends by various devices, e.g., loose string at one end and a loop at the other, or with basal strings left free to tie back into the main string (doubled), or with the basal strings at either end overwound partway but left loose at the ends for tying (Text fig. 3e). The workmanship of these decorative strings is skilled

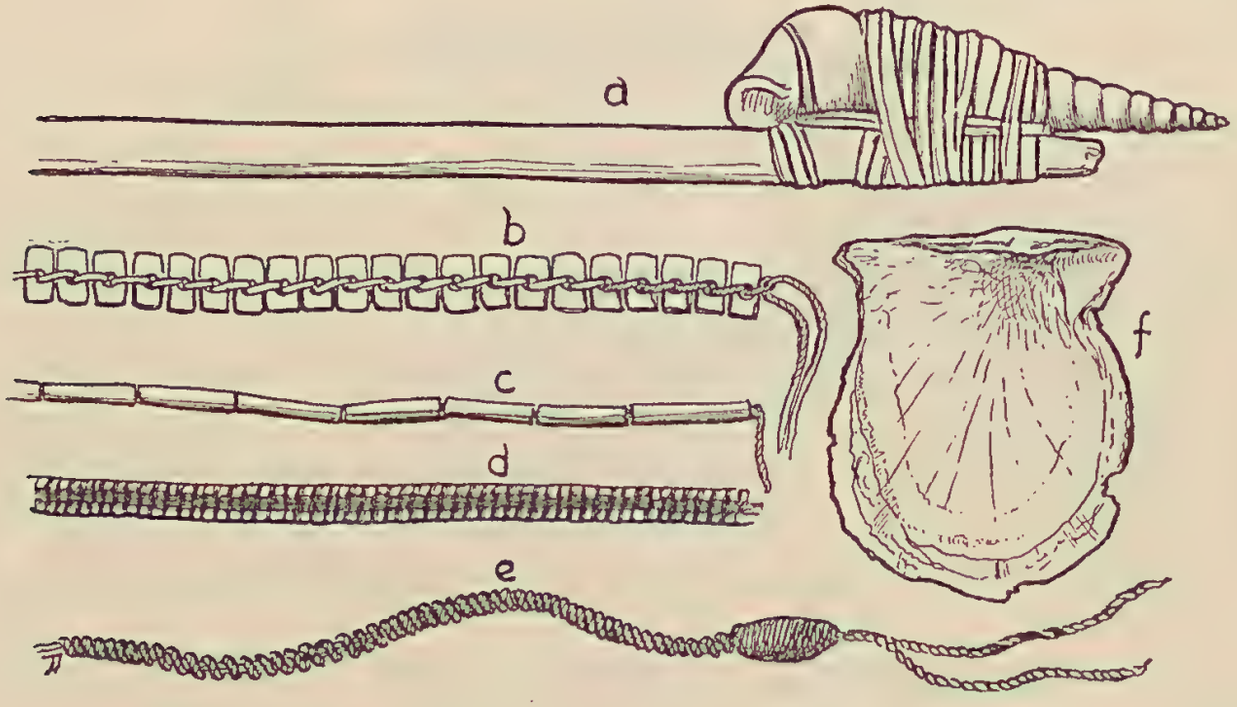

Fig. 3. Shell drill and ornaments. a. *Turritella cerea* drill for piercing shells. b. *Nautilus* shell necklace. c. Necklace of grass bugles. d. Flat band ornament of *Dendrobium* orchid epidermis and string. e. Overwound strings worn as ornament. f. *Pinctada margaritifera*, a fragile pearly shell used in ornamental necklace making.

and artistic. A small, fragile pearlshell (*Pinctada margaritifera*, Text fig. 3f) found on the Gulf shore is used instead of the coarser *Nautilus pompilius* to make a fine pearl necklet or headband, worn by men and women. Holes are drilled in the pearlshell by means of a spiral shell *(Turritella cerea)* which is fastened to the end of a stick (fixed so that the point is in a central position) and twisted between the hands like a firestick (Text fig. 3a). The small pieces of shell, each with its centre-hole, are ground and sharpened by means of solidified shell-grit and then strung on twine which is twisted so that the rectangular pieces lie flat (Text fig. 3b). The epidermis of the *Dendrobium johannis* orchid (wilted to yellow in the fire) is plaited in and out of a string-base to form a flat band (Text fig. 3d), which may be worn round the head or arm or leg by

men, and long and doubled as a girdle or crossover breastlet by women. Sometimes twine is interwoven with soft white jabiru-down and, folded and twisted into a number of strands, worn as a crossover breastlet or girdle by the women, showing dazzlingly white against their brown skins. Golden grass-bugles, fine and coarse, are gathered together into a number of strands and tied round the neck, or, folded over a number of times, passed over the head as crossovers and girdles, or sometimes in single strand worn hanging from the head down the back for mourning.

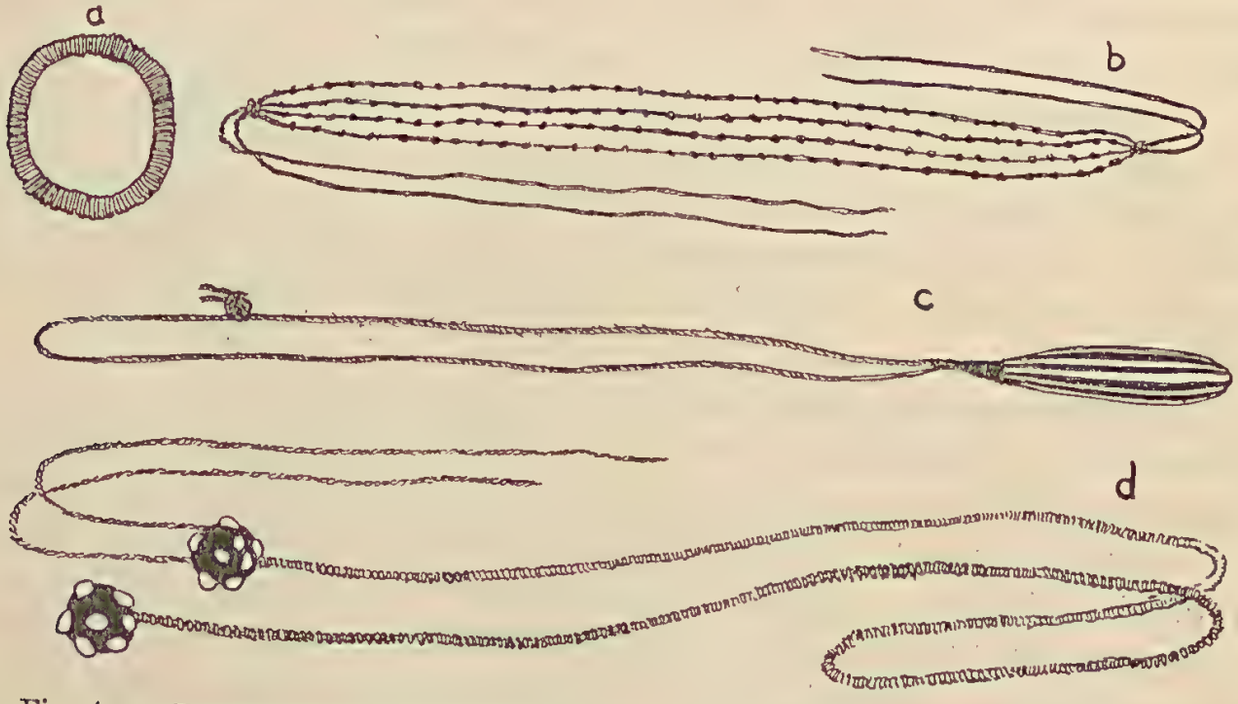

Fig. 4. a. Betrothal ring of string, overwound. b. Lover's string, dyed red. c. Umbilical cord in wax pendant, decorated with yellow orchid bark stripes. d. Widow's string neck ornament with wax balls decorated with red *Abrus* seeds fastened with beeswax.

In addition to these decorative strings, worn for ceremonial purposes in general, strings are used also for specific purposes. The most common of these is the circular overwound plain string worn as a crossover (single or doubled) for mourning; the crossover goes over neck and underarm, i.e., across the breast. It is worn by widows but is not compulsory. The compulsory widow's string is made of overwound twine, with blobs of beeswax at the ends. It is worn round the neck, fastened in front, with the ends crossed again at the back and hanging down behind. Sometimes the beeswax blobs are studded with scarlet seeds and have the basal strands left loose for tying so as to make the necklet more secure (Text fig. 4d). The wearing of the widow's string is compulsory until mourning ends. If it should wear out, it must be replaced, but the old one must be kept also. If a widow should lose her mourning necklet and be seen walking about without it, she would be killed by her husband's relatives.

A small plain ring (Text fig. 4a), made in the same overwound technique, is used in the betrothal ceremony as a symbol of the promise made by a woman to give her daughter in marriage to a man. In this ceremony her head is covered with a sheet of bark (on account of the strict taboo existing between son-in-law and mother-in-law), as, accompanied by another woman (acting as proxy for the promised daughter) she encircles the man seated on the ground and places the ring over a tuft of his hair and hangs a dillybag over his head. The betrothal ring is kept by the man as a surety for his promised bride. When the marriage takes place the ring is placed under honey in a bark vessel, as the last payment due to future mother- and father-in-law.

A lover's string *(manenka)*, made of several fine strands of twine, plain or knotted and coloured with red clay (Text fig. 4b), is sent by a woman to her lover by the hand of this man's half-sister, in whom she can confide. On receipt of it, the lover sends her back a message arranging a rendezvous, saying: "You pretend to go for yams, and I will go hunting," and they meet at the time and place arranged.

A baby's umbilical cord (which it is considered essential to preserve), finished with a wax pendant striped with yellow orchid bark (Text fig. 4c) is hung around a baby's neck when it is presented to its father, on the occasion of the mother's return to her husband's camp after childbirth. The father accepts the child as his own and as a member of his clan, anoints its face with his sweat so that the clan spirits will recognise it as "belonging." Later the child is given a name identifying it with a clan totem through a "namesake," who acts as its guardian should anything happen to its father.

THE USE OF CLAYS IN RITUAL.

In ritual and ceremonial art the use of coloured clays is unlimited. Painted on the body, clays are used with an endless variety of meanings according to the ritual and the ceremony concerned. In everyday life clays are used in sickness to cool the body. When a baby is presented to its father, a white streak is painted down its nose (the significance of which I am uncertain) and the child is also rubbed with charcoal to cover any remaining lightness of skin. At the betrothal ceremony, a white streak is placed on the abdomen of the girl's mother's brother, denoting his relationship to her through the mother, and his responsibility for his sister's promise; the girl's father touches the man's head with his spearthrower as a gesture of subjection and the girl's brother rubs chests with him as a sign of his acceptance of the pledge. In initiation ceremonies, women paint their bodies (Plate vi, fig. d) in a manner signifying their

relationship to the initiates, e.g., "mothers" paint their breasts with red and white clay and hold the breast as if to feed, symbolising a maternal relationship; a "father's sister" paints a circle on her shoulder and holds her hand there in the attitude of steadying a child by the knee when carrying it on her shoulder, whilst a "sister" paints her legs with white stripes and holds her hand behind her head in the manner of supporting a baby's back, when carrying it on the shoulder. Sometimes two or all of these symbols and attitudes are combined to signify a variety of relationships on the part of one woman. In mourning dances, women of the deceased's clan and moiety paint their faces and bodies with red and white clay, and wear the mourning strings, apron, and other ornaments alluded to above.

In all sacred ritual and ceremonial, red and white clays are used by the men to denote the peculiar significance of the ceremony. Totemic emblems are painted on the bodies of the men who take part in the ritual of their own totemic clans. For example, men of the bony-bream clan have a male and female fish paintd on their chests, men of the cuss-cuss opossum clan are covered in white spots, and men of the tortoise clan have a tortoise painted in white clay on the back, etc. A white mark down the abdomen denotes the female of the species. In the bony-bream ceremony, the male and female bony-bream appear covered respectively in red or white clay, according as each "steps out" of a bloodwood or a milkwood tree. In addition to clays, feathers are used, e.g., as headdresses, held together with gum or wax. Wax is used for modelling—as in the case of the figurine of a baby (Plate v, fig. f, and Plate xvii, fig. f). Wood also is used, e.g., for making ceremonial objects such as the bull-roarer (Plate v, fig. a), wooden phallus (Plate v, fig. d), etc. Bark is used for representing various objects, such as a fish carried in the beak of a bird (Plate v, fig. e, and Plate vi, fig. b), *pulwaiya,* etc. There is no end to the uses made of such available materials, of which the examples quoted are but an inadequate indication.

RELIGION AND DRAMA.

The creative talent of these people is revealed not only in their technical skill and ingenuity in the manufacture and the artistic finish of objects of everyday use, and their decorative and ritualistic art, but is seen to perfection in the dramatic portrayal of religious beliefs associated with the cults of their clan totems or *pulwaiya.* For behind all these economic activities, and the ritual attending the crises of life, behind the sanctions which govern mental attitudes and behaviour patterns, even behind all natural phenomena, beneficial or otherwise, lies the belief in a spirit world, conceived in terms of these *pulwaiya,*

whose abode is known, who permeate all reality and are the source of all that exists, who control and maintain all forms of life and inherent capacities, and whose creative and inventive activities "in the beginning" *(ke:nka)* established the world as it is today and who sanctioned the present social order. These traditional beliefs absorbed implicitly by one generation after another, are made explicit in the social consciousness by means of ritual and the recital and dramatic portrayal of the prowess and creative powers of the *pulwaiya.* It is only in the light of such beliefs that present activities and skills can be properly evaluated.

Every cult, whether it be associated with food supplies, forces of nature or with human attributes, has its "story," its drama and ritual and its *auwa,* where natural and human factors are merged by the incarnation of the human *pulwaiya* in some material form. Each *auwa* is marked by a tree, water-hole or antbed, in which the *pulwaiya* resides and whence its creative power emanates. On the upper Kendall River, where the fresh-water bream breed, is a small circle of antbeds with a line of them leading from these spirit-camps down to the water-hole. On the upper Archer River a small circle of antbeds marks the *auwa* of the cuss-cuss opossum. All such shrines are kept in order and swept with branches and revered as the abode of the *pulwaiya* is felt to be there. At the mouth of the *Tokali* River—at the *auwa* of *oiya ŋo:pan,* the rock python, the trees on which the spirit-snakes sun themselves are sacred and must not be touched for fear of creating a bush-fire. Sweat must be smeared on strangers who approach so that they may be recognised by *oiya ŋo:pan* as "friends." On the Great Dividing Range in which these rivers rise, where stones and rocks are plentiful, these *auwa* often are marked by stones, e.g., the rock-cod family marked by three stones (father, mother and child), and the kangaroo *pulwaiya* by a line of stones crossing a ridge with a larger "old man" in the lead (McConnel 1931). Though separately conceived, all these cults are implicitly comprehensive and complementary and together cover the whole field of man's orientation to reality in all its forms.

Only those cults associated with ceremonial objects shown in this collection are described here, for the better understanding of the nature and function of these objects. Incidentally, these cults deal with two most important aspects of social life: (i) the source of food supplies; (ii) the crises of life, associated with the sex relationships and childbirth.

A. The cult of Wɔlkɔlan, the bony-bream pulwaiya.

Members of the bony-bream clan are the custodians of this cult. Every year, when the bony-bream come up the river to breed, word is sent to neighbouring clans to come for the fishing season and share in the proceeds of the

hunt. *Wɔl̩kɔl̩an* has his abode *(auwa)* in a small creek off the lower Archer River, where a spring breaks through the bank into a waterhole, in which the bony-bream breed. Here a ritual for the increase of the bony-bream periodically takes place. With stamping of feet and hitting of the surrounding trees in which the spirits of the bony-bream reside, men call upon *Wɔl̩kɔl̩an* to send out a plentiful supply of bony-bream into the river for men to spear for food. The measure of the response of *Wɔl̩kɔl̩an* to this "awakening" ritual dramatically was revealed to an initiate of this clan during the initiation ceremony, a ritual which I was permitted to attend. In response to the rhythmic chanting and clapping of hands came an answering call as the female spirit of the bony-bream emerged from a group of trees. She was covered from head to foot in white clay (having "stepped out" from a milkwood tree). She was crowned with a semi-circle of feathers of the peewit (an associated clan *pulwaiya*), her body was riddled with the spears of her slayers. She staggered forward to the rhythmic chanting (legs and arms outstretched and head falling forward). She paused now and then, only to be called into action again by the chanters. Beside her stood Wɔl̩kɔl̩an, covered with red clay (having "stepped out" of a bloodwood tree). Kneeling at the feet of *Wɔl̩kɔl̩an,* a suppliant, with a feather fan, raised (by sleight of hand) the wooden phallus into creative activity in response to his people's call for a plentiful supply of bony-bream (Plate v, fig. d). Innate in this dramatic portrayal of the *pulwaiya* answering the call of this people, staggering under spear wounds inflicted through a willing incarnation as bony-bream, slain that people may eat and live, lies the belief in a beneficent and creative deity and a spirit of voluntary self-sacrifice. For a full description of this cult see McConnel (1935).

B. The cult of the "Bull-roarers."

This cult is not confined to one clan or tribe but is a series of cults, associated by their own inner logic with one another, each with its own *auwa* and *pulwaiya,* and each concerned with one aspect of the phases through which a woman passes in her development from (a) a girl entering puberty *(kɔman manya)* to (b) a mature girl *(kɔman),* (c) a married woman *(wantya pi:'an),* (d) a married woman who has given birth to a child *(kaṭa).* The bull-roarers vary (in order of the above) from (a) a small, plain leaf-like piece of wood *(moiya)* to (b) one similar but larger *(pakapaka),* (c) a larger one coloured red with white splotches *(moipaka)* which is one of a pair (husband and wife), the male being phallic-shaped and painted red with long white stripes and dots, and (d) a female *moipaka* similar in shape but painted red with white stripes

across, which is used (Plate v, fig. a) in association with the ritual of a woman with a child *(ka:ṭa)* (Plate v, fig. f), the latter being represented by a wax figurine of a newborn male baby, complete with eyes (scarlet seeds), teeth, pubic hair, etc., lying on the abdomen of the "first woman" (Plate v, fig. f).

The "bull-roarers" *moiya* and *pakapaka* are swung respectively by young initiates at the end of the first part and at the close of the *U:tyanam* ceremony; the first *moipaka* is swung by men for married women, and the last *moipaka* in association with the ritual of childbirth. Each has its own story of origin, its ritual and drama, and its place in relation to social life.

The dramatic presentation of these symbolic ideas concerning the "bull-roarers" and their *auwa* was vivid and arresting, coming as it did without any expectation on my part. These dramatic scenes are described here just as they were witnessed by me.

(a) A *kɔman manya* vehemently swung the *moiya* whilst other *kɔman 'manya* lay stretched on the ground—they represented those who had gone down into their *auwa;* after hiding the *moiya* in a crack in a bloodwood tree "for men to use," she too went down into her *auwa.*

(b) The *pakapaka* was swung by a *kɔman* (white clay on breasts to indicate her sex), whilst the *u:tyana* (initiates) stood hand in hand apparently listening. The marks on the *u:tyana* were those used for initiates in the *U:tyanam* ceremony (McConnel 1935). It is from these "girl" *auwa* (girls having first possessed the *moiya* and the *pakapaka*) that the power of awakening adolescence and maturity are believed to come in response to the swinging of the "bull-roarers" by the *u:tyana,* who now assert their claims over the swinging of the "bull-roarers" relinquished by the girls.

(c) A line of figures lie prone on the ground with arms outstretched and hands interlocking, on the abdomen of one of which *(wantya pi:'an)* lies the female *moipaka.* She represents a married woman, as yet without child. The *moipaka* (man and wife), having found each other, have entered a state of married life. The female *moipaka* is swung by a man for "married woman," invoking the virility from this *auwa.*

(d) A line of figures similarly lying, on the abdomen of one of which is *ka:ta,* the wax figurine of a new-born male baby. This represents the first birth. The figures on one side of the woman with a child are the first men who inhabited the earth and who were growing old with no one to replace them; those on the other side of "the woman with a child" are those who, coming after this event, are born of woman in the ordinary way. A man at the end of the line swings a *moipaka.* The idea symbolically presented here is "the continuity of life

through birth, and its first coming.'' The interlocking of hands denotes continuity, and the swinging of the *moipaka* preservation of that continuity.

(e) The female *moipaka pulwaiya* sits with her child on her knee (the first child ever created) with her husband beside her, the three together representing the institution of family life. Sitting thus in their camp, the *moipaka pulwaiya* father, mother and child go down into their *auwa,* whence more babies now come. From these ''bull-roarer'' *auwa* are believed to emanate those mystic forces intimately concerned with the maintenance of sex relationships, which the ''bull-roarers'' symbolise, and the sanctions which govern their social stratification (McConnel 1935).

The primitive symbolism of these cults should not mislead us into underestimating their psychological and sociological value. They are the means by which individual experience is socialised and made explicit in the social consciousness. They are a basic support of social structure and the concrete expression of abstract ideas such as we are accustomed to express in more sophisticated language, with the accumulated knowledge of thousands of years enabling us to do so.

The ethnological specimens upon which the foregoing analysis is based are in the South Australian Museum under the registered numbers listed here. Duplicates of many of these specimens have been passed to the Australian Museum, the University of Sydney (Department of Anthropology), and the University of Queensland.

SPECIMENS SHOWING OUTSIDE INFLUENCE.

A.42055. Drum (Plate vii, fig. a). This is a hollow wooden cylinder, slightly tapered; over larger end-hole is stretched skin of a lizard; beaten by hand—palm of hand for deep notes and fingers for lighter sounds—used with one or both ends closed, as in Papua. It is used in ceremonial dance of totemic hero *Sivri,* the seagull, among the *Tyɔŋandyi* tribe (Batavia River), who is said to have introduced it from the Torres Straits; not found south of Archer River.

A.42066-67. Bows (Plate vii, fig. l-m). Specimens used in dances associated with cults of totemic hero *Sivri.* (*Tyɔŋandyi* tribe, Batavia River). Not found south of Archer River.

A.42068-69. Arrows (Plate vii, fig. n-o). The points of these arrows are missing. They are used with the above bows.

A.42056-57. Shell Nose-Peg (Plate vii, fig. b-c). *Wikmuŋkan* name *ka:woiyama.* Nose ornament pierced through hole in nose; made from *Megala-*

tractus aruanus or *Turritella cocea?* This specimen is from Kendall, Holroyd and Archer Rivers area.

A.42058-59. SHELL PENDANTS (Plate vii, fig. d-e). Semi-lunate or oblong pearlshell ornament, worn mostly by men suspended from neck; pearlshell usually traded in from east coast and the Torres Straits. These specimens are from Kendall, Holroyd and Archer Rivers area.

A.42063. DANCING SKIRT (Plate vii, fig. i). The skirt is made from strips of hibiscus bark and worn by men in dances. Found north of Archer River: associated with the Batavia River hero cults of *Sivri* the seagull and *Nyuŋgu* the Torres Straits pigeon, said to have been introduced by them.

A.42060. SHELL NECKLET (Plate vii, fig. f). *Wikmuŋkan* name *wa:taku:pa.* The necklet is made of rectangular pieces of nautilus shell strung together; the shell is traded from East Coast and Torres Straits. Specimen collected from Kendall, Holroyd and Archer Rivers area.

A. No specimen. EAR ORNAMENT. A large wooden cylinder painted red and white and worn through lobe of ear, Papuan fashion. Used in Kendall, Holroyd and Archer Rivers area.

A.42061-62. ARMLETS (Plate vii, fig. g-h). Plaited strips of pandanus-palm leaf from Kendall, Holroyd and Archer Rivers area, worn by men (Torres Straits Islands fashion).

A.42064. PIPE (Plate vii, fig. j). Native name is *märippa.* It is a wooden cylinder, sealed at both ends, with two holes, one to hold bark cigarette and the other for drawing smoke into mouth. The pipe is passed from one to another with finger held over hole to prevent smoke escaping. This type of pipe is used in Papua, also by men on Archer River (Papuan fashion).

A.42070. CLUB (Plate vii, fig. p). Named *mɔrikan.* A two-pronged club, decorated with black seeds; traded in from Torres Straits Islands. The head is used to knock back spears.

A.42071. CLUB (Plate vii, fig. q). Native name *mɔrikan.* Pineapple type of club, traded in from Torres Straits Islands and used to knock back spears.

A.42065. BOOMERANG-SHAPED CEREMONIAL OBJECT (Plate vii, fig. k). Decorated with pipeclay and strips of orchid bark; significance not recorded. The boomerang is not used in this area.

AXE. An unhafted axe traded in from south or east; found on Kendall-Holroyd River and rehafted.

KNIFE (no specimen). Is named *koiyama.* Traded in. *Wikmuŋkan* name.

DOUBLE-OUTRIGGER CANOE (no specimen). This is made from hollowed-out milkwood tree; the booms are usually in two pieces and lashed to a stick placed

through gunwales towards prow and stern; floats on either side are lashed to booms. Made on Batavia, Embley and Archer Rivers and used along the Gulf Coast as far south as Edward River. It was introduced from northern neighbours and is not indigenous art. Vide: Hale and Tindale (1933, fig. 150-151) and Haddon and Hornbill (1937).

INDIGENOUS SPECIMENS FROM ARCHER, KENDALL, HOLROYD RIVERS AREA.

A.42001. Short Fighting Spear (Plate viii, fig. a). *Wikmuŋkan* name, *ku:'iŋa*; has no barb; acacia head and bamboo shaft; is used for fighting at a distance.

A.42002. Butt End of an example identical with A.42001 (Plate viii, fig. b). An imitation butt; used for fighting at a distance; average length 60 inches.

A.42003. Short Fighting Spear (Plate viii, fig. c). *Wikmuŋkan* name *pepin*. There is no barb, has acacia head and lightwood (hibiscus) shaft. It is used for fighting at a distance.

A.42004. Short Fighting Spear (Plate viii, fig. d). Native name, *paŋkata*. There is no barb, has acacia head, cottonwood, bamboo or grass tree shaft and is used for fighting at a distance (also for wallaby).

A.42008. Long Fighting Spear (1 prong) (Plate viii, fig. h). Native name, *keka yandala*. It has a long acacia point and shaft in one (imitation join, poisonous gum?), wallaby or emu bone barb with short cane or softwood butt; notch at end to fit spearthrower. It is coloured red and white at end of shaft and has circle of white edged with red at foot of point.

A.42009. Butt End of example identical with A.42008 (Plate viii, fig. i).

A.42015-17. Long Fighting Spears (Stingray Barbed) (Plate viii, fig. o-q). Native name, *wɔḷka*. Has a long hardwood head spliced to lightwood shaft; 1-3 stingray barbs (white) with imitation painted butt. Painted when given to initiates at end of second initiation ceremony (e.g., note white rings on head of A.42017). These spears are used for spearing in the leg, a punishment for infringement of tribal law or misconduct, etc.

A.42016. Butt End of example identical with A.42015 (Plate viii, fig. p).

A.42019-23. Long Fighting Spears (Stingray Barbed) (Plate viii, fig. r-w). This is called *kaiya* and is a flower-like cluster of stingray barbs mounted on stemlike head of acacia wood (white and red) and is attached by gum to bamboo or softwood *(Hibiscus)* shaft. Blood is smeared on bamboo shaft in waving pattern by twisting spear in blood-stained hand. Note ceremonial paint-

ing on butt ends (Plate viii, fig. u and x). They are punitive or fighting spears; e.g., used for spearing in the leg as punishment for infringement of tribal law or misconduct, etc.

A.42024. BUTT END of example identical with A.42023 (Plate viii, fig. x). A ceremonial spear, red and white paint on shaft; has been decorated for an initiation ceremony.

A.42025. LONG FIGHTING SPEAR (STINGRAY BARBED) (Plate viii, fig. y). Spear, *etiketa,* with successive stingray barbs (white) lashed on to acacia head, facing backwards and serially arranged; with bamboo or lightwood *(Hibiscus)* shaft. A punitive or fighting spear used for spearing in the leg as punishment for infringement of law or misconduct, etc.

A.42005. LIGHT HUNTING SPEAR (Plate viii, fig. e). *Wikmuŋkan* name, *pi:nta.* It has long bamboo shaft, one-pronged hardwood head and double-pointed bone lashed on to acacia or ironwood point to form a terminal barb. A long, light spear used for fish, birds, goanna, native companion, etc.

A.42006. LONG HUNTING SPEAR (1 PRONG) (Plate viii, fig. f). This spear, *ţu:'u* has (a) a short butt (ceremonial); (b) long butt (utility); head and shaft of acacia in one piece; strip of gum in imitation of join; butt of hibiscus or other softwood; milkwood gum on point; ironwood gum on lower part of head; has ceremonial paint (red and white circles) on shaft. This is used for spearing bony-bream from canoe on lower Archer River and in ceremony of bony-bream totem (McConnel 1936).

A.42007. BUTT END OF A.42006 (Plate viii, fig. g).

A.42010. LONG HUNTING SPEAR (3 PRONGED) (Plate viii, fig. j). Called *wantan dyindan,* has a softwood shaft *(Hibiscus);* acacia head; 3 points with bone barbs; false butt effect in painted white butt-end of shaft. This is used the same as A.42006.

A.42011. LONG HUNTING SPEAR (4 PRONGED) (Plate viii, fig. k). *Wikmuŋkan* name is *pita pi:nta.* It is a bamboo shaft with 4 acacia points, each with terminal double-ended bone barb lashed on to form a barbed point; the light end of cane is at butt end. This is used for hunting emu, wallaby, jabiru, fish, etc.

A.42012. BUTT END of example identical with A.42011 (Plate viii, fig. l).

A.42013. LONG HEAVY HUNTING SPEAR (4 PRONGED) (Plate viii, fig. m). *Wikmuŋkan* name, *keka äntyan.* There is a double-pointed terminal bone on each of the 4 hardwood points. It is used for hunting big game. This specimen has (a) *Acacia* wood shaft, imitation butt fitting into spear thrower; (b) *Pita pɔlɔŋki,* grass tree shaft; (c) *Pita ɔkindya, Hibiscus* wood shaft.

A.42014. Butt End of example identical with A.42013 (Plate viii, fig. n).

A.42045-47. Spearthrowers (Plate x, fig. f-h). Named *tu:liŋa:* (*tu:la kantya* = nose or peg; *tu:la maŋka* = neck where held; *tu:la mampa* = shell end). This has a flat shaft, plain smooth surface, varying in width; sometimes expanded in breadth, contracting towards handle-end, which is plastered with gum and fastened between two bailer discs, against which spear is balanced; wooden peg at other end into which spear is hooked; ornamental yellow orchid bark bands, and scarlet abrus seeds sometimes inserted into gum between shell discs. It is used to give added force and length in throwing spear.

A.42048. Wax. A stick of wax on carrying stick.

A.42051. Sinew (Plate x, fig. l). Wallaby-tail sinew prepared for use in fastening-on spear barbs.

A.42049. Gum (Plate x, fig. j). A stock of grass-tree gum on carrying stick for use on spear point after barb is fastened on to point.

A.42050. Bailer Shell *(Melo amphorus)* (Plate x, fig. k). Native name, *weḷa.* It is used for melting gum on fire before putting over spear point, used also for bailing out water and for drinking purposes.

A.42053. Palette (Plate x, fig. n). *Wikmuŋkan* name, *kaiyaman.* A wooden palette with projection for engraving; used for smoothing hot gum on spear point.

A.42054. Palette (Plate x, fig. o). *Wikmuŋkan* name, *kaiyaman.* A wooden palette with incisor tooth of wallaby or kangaroo attached to projection for use as engraver.

A.42052. Bark Bundle (Plate x, fig. m). Made of folded ti-tree bark and tied with string; used for carrying stingray barbs, etc., and for use in spear making; found in a man's dilly-bag.

Bark Canoe (Specimen in Queensland Museum). Canoe is made from strip of messmate tree bark shaped at ends and sewn up with cane by using a bone stiletto; sides drawn together with straps of green hibiscus bark and kept open by forked sticks supporting ties; paddled by young mangrove stem splayed at the end, and used in fishing and for crossing rivers. (Plate i, fig. b-d.)

A.42041-42. Fighting Sticks or Clubs (Plate x, fig. b-c). These are hardwood, flat, pointed and red ochred. Used by men for fighting at close range or for warding off spears.

A.42043-44. Clubs (Plate x, fig. d-e). Rounded clubs with knob at end; used for warding off spears.

A.42040. Short Yam Stick (Plate x, fig. a). *Wikmuŋkan* name, *katyan.* It is made of hardwood and used by women for digging out roots, etc.

A.42026. LONG YAM STICK (Plate ix, fig. a). *Wikmuŋkan* name, *ka'tyan*. Hardwood yam stick pointed at one end, used by women for digging out roots, goanna, bandicoots, etc., and for stripping bark, etc.

A.42027. POINTED END OF YAM STICK similar to A.42026 (Plate ix, fig. b).

A.42028-29. FIGHTING STICKS (Plate ix, fig. c-d). *Wikmuŋkan* name, *katyan-ɔ:taka* or *katyan pu'ŋka*. These are painted red with white points and used by women in fighting each other; the photographs show opposite ends of the two specimens.

A.42030-31. FIGHTING STICKS OR CLUBS (Plate ix, fig. e-f). These are short fighting sticks and are used by women taking part in fight to hit back at opponents' long fighting sticks. The photographs show only the head end of one and the butt of the other.

A.42032-36. CHILDREN'S SPEARS (Plate ix, fig. g-k). These have wooden points let into reed shafts and fastened with strips of bark fibre string; average length 50-53 inches. (a) Portion of bark left on wooden point in imitation of poison gum used in similar place on adult fighting spears. (b) Plain, no bark strip. (c) Imitation prong, made by fastening string round place for joining; imitation poison gum on point. Plate ix, fig. h, shows the butt end of a spear identical with A.42032.

A.42037-39. FIRE STICKS (Plate ix, fig. l-m). *Wikmuŋkan* name, *tu:mpu:piya*. Two long sticks made of match-wood (match-box bean); carried in sheath made of two hollow bamboo tubes, fastened together by strips of orchid bark *(Dendrobium johannis)* burnt yellow on the fire and wound round and round the tubes, which are held together at end by a knob of black bees-wax, studded with scarlet seeds of *Abrus precatorius;* black, yellow and red represent the colours of fire. Method of using fire stick is to place one on the ground, steadied by foot, and to spin the other downwards between the hands to create friction against the one on the ground.

A.42081. STEMS OF FICUS CUNNINGHAMII (Plate xi, fig. a). *Wikmuŋkan* name, *ŋa:tan*. Samples of raw material from which string *(koiya)* is made by stripping off bark.

A.42082. STRANDS OF FICUS CUNNINGHAMII (Plate xi, fig. b). *Wikmuŋkan* name, *koiŋa:tan*. Strands stripped from stem of *Ficus* and used for making twine; sometimes used in this rough state also for tying purposes.

A.42083. BUNDLE OF FICUS CUNNINGHAMII (Plate xi, fig. c). *Wikmuŋkan* name *koiŋa:tan*. It is rendered soft by chewing in the mouth and used for making twine.

A.42084. STRANDS OF FICUS CUNNINGHAMII (Plate xi, fig. d). Ready for use in making 2-ply twine by twisting strands together with palm of hand against thigh.

A.42085-87. Twine, Completed (Plate xi, fig. e-g). *Wikmuŋkan* name, *koiya*. It is made from *Ficus* fibre; of varying thicknesses—coarse, medium and fine.

A.42088. Strands of Completed Twine (Plate xi, fig. i). Twine is caught together into required size and fastened at top by overwinding; sometimes worn in this unfinished state.

A.42089. Twine Circlet (Plate xi, fig. j). Circlet is in overwinding pattern and only partially completed.

A.42090. Twine Circlet (Plate xi, fig. k). Overwinding completed.

A.42095. String Apron (Plate xi, fig. o). *Wikmuŋkan* name *wa:ta*. A small apron made of *Ficus* twine *(koiya ŋa:tan);* long loops suspended from waist-string (single loop) and fastened behind; rolled for carrying and usually wound around a stick or piece of bark; worn by young girls at onset of puberty.

A.42096. String Apron (Plate xi, fig. p). *Wikmuŋkan* name, *wa:ta*. A woman's apron made of *Ficus* twine *(koiya ŋa:tan)*. It is worn by a woman on special occasions such as presentation of child to its father, mourning dances, etc.; rolled, with loop out for carrying.

A.42093. String Apron (red) (Plate xi, fig. m). *Wikmuŋkan* name, *wa:ta*. A woman's apron made of *Ficus* string *(koiya ŋa:tan);* dyed with red ochre; worn on special occasions; rolled, with loop out, for carrying.

A.42094. String Apron (white) (Plate xi, fig. n). *Wikmuŋkan* name, *wa:ta*. The twine is made from strips of white under-epidermis of leaves of *Livistona* palm *(koi-tu:ṭa)*. It is worn by women on special occasions, such as presentation of child to its father, mourning dances, etc.; rolled, with loop out for carrying.

A.42092. String Apron (yellow) (Plate xi, fig. l). *Wikmuŋkan* name, *wa:ta*. The twine is made from *Ficus cunninghamii,* stained yellow with root or stem of *Morinda citrifolia* or leaves of *Alphitonia crotonoides*. It is worn by women on special occasions, such as presentation of child to its father, mourning dances, etc.; rolled, with loop out for carrying.

A.42091. Root of Morinda citrifolia (Plate xi, fig. k). A powdered root used to clean aprons and dillybags, dried in sun and rubbed off again; leaves a yellow stain used for colouring, if desired, as above.

A.42097. Woman's Utility Pad and String (Plate xi, fig. q). *Wikmuŋkan* name *mu:ta me:'a*. It is a strip of ti-tree bark *(Melaleuca leucadendron)* used as a pad during menstruation; passed between legs and fastened at waist both back and front by folding ends under waist-string; carefully burned and buried after use.

A.42098. BARK TORCH (Plate xi, fig. r). Bark is of *Melaleuca leucadendron (kitya tumpa);* rolled into longish bundle and tied round with strands of the bark. It is used as a flare at night, e.g., finding one's way around the camp, attracting prawns, or when fishing for bony-bream from canoe at night time, etc.

A.42099. BARK BUNDLE (Plate xi, fig. s). It is tied round with twine and used to carry spear-barbs, clays, etc.

A.42134. BARK HEAD PROTECTOR (Plate xv, fig. d). Bark twisted into pad for wearing on top of head to distribute weight and lessen strain in carrying loads; used by women.

A.42145. DILLY-BAG (Plate xiii, fig. h). *Wikmuŋkan* name, *wa:ŋka ŋa':tan.* A large dilly-bag made from fig-tree fibre string *(koiya ŋa:tan)* in figure-of-eight double-loop pattern and used for carrying roots of all kinds.

A.42146. DILLY-BAG (Plate xiii, fig. c). *Wikmuŋkan* name, *wa:ŋka pɔ:la.* String twine made from red acacia *(Acacia flavescens* or *A. latifolia),* sometimes alternated with white *Livistona* twine to give striped effect; figure-of-eight pattern; used for carrying heavy loads.

A.42143. DILLY-BAG (Plate xiii, fig. f). *Wikmuŋkan* name, *wa:ŋka me:'a.* The fine white twine is made from epidermis of leaf of *Livistona australis;* figure-of-eight pattern; sometimes alternates with *Ficus* or *Acacia* twine to give striped effect; used for carrying lighter loads.

A.42144. DILLY-BAG (Plate xiii, fig. g). *Wikmuŋkan* name, *wa:ŋk ɔ:nyana.* The twine is from dark *Ficus* fibre in pattern used for making fish nets.

A.42155. FISHING NET (Plate xii, fig. a). *Wikmuŋkan* name, *puntäman.* Made from fibre of *Acacia holosericea (koiya gɔ:ka)* or its equivalent; in figure-of-eight pattern; held at top by looped cane; usual pattern for fish nets is that used in dilly-bag A.42144 *(wa:ŋk ɔ:nyana),* i.e., fish net pattern.

A.42148. XEROTES MULTIFLORA (SAMPLE) (Plate xiv, fig. c). *Wikmuŋkan* name *kämpian.* It is used for making grass-baskets after soaking in water to soften.

A.42149. GRASS BASKET (INCOMPLETE) (Plate xiv, fig. b). *Wikmuŋkan* name, *kämpian;* in course of manufacture.

A.42147. GRASS BASKET (COMPLETED) (Plate xiv, fig. a). *Wikmuŋkan* name, *kämpian.* A large open basket, handle of fibre-string overwound; sometimes with white jabiru-down interwoven to render it soft against head or shoulder in carrying; used by women to carry roots, etc.

A.42150. GRASS-BASKET (PARTIAL CLOSE-WEAVE) (Plate xiv, fig. f). Native name, *kämpian.* It is closely woven at base to hold meal when washing (after grinding) to cleanse from poisonous or indigestible substances; wad of bark

fastened to end of string handle to ease strain on side of basket; handle not overwound.

A.42151. Grass-Basket (all close weave) (Plate xiv, fig. e). *Wikmuŋkan* name, *kämpian*. This specimen is closely woven throughout to hold moist substances, e.g., honey; handle partially completed.

A.42154. Grass-Basket (Plate xiv, fig. h). *Wikmuŋkan* name, *kämpian*. It is closely woven and coloured with white and red clay; tubular shaped; specially woven for carrying honey.

A.42153. Grass-Basket (Plate xiv, fig. g). *Wikmuŋkan* name, *kämpian*. A small, tubular-shaped, closely woven basket used by men for carrying small treasures, e.g., tobacco.

A.42152. Grass-Basket (Plate xiv, fig. d). *Wikmuŋkan* name, *kämpian*. A small, tubular-shaped, coarsely woven basket used by men for carrying small treasures, e.g. tobacco.

A.42140. Livistona australis (Plate xiii, fig. b and e). A bundle of strands from underneath of palm leaf, and twine made from same. *Wikmuŋkan* name, *koi tu:ṭa*. This is raw material used for making 2-ply twine (white) from epidermis of under-leaf of *Livistona*.

A.42141. Dilly-Bag (Plate xiii, fig. a). *Wikmuŋkan* name, *wa:ŋk iyampan*. This specimen is made from white twine of *Livistona australis* in grass-basket chain and twist pattern (anti-clockwise), which lends itself to this pattern; handle of overwound type, not yet joined in centre. Positions of handles to one side allows bag to lie flat against back as it hangs from the head, and also leaves room for hand to pass in and out easily.

A.42142. Dilly-Bag (Plate xiii, fig. d). *Wikmuŋkan* name, *wa:ŋk iyampan*. It has handles equidistant on sides of it.

A.42135. Scirpus littoralis (old corms on stalk) (Plate xv, fig. k). *Wikmuŋkan* name *pändya* or *mai ku:tala*. Corms dug from edge of swamp by women who sit up to the shoulder in mud as they dig. (Plate iii, fig. a). Old corms beaten into flat cake after cooking in fire.

A.42136. Scirpus littoralis (young corms on stalk) (Plate xv, fig. l). *Wikmuŋkan* name, *pändya*. Corms are cleaned and tied together for carrying. The young corms are roasted and eaten without beating first.

A.42137. Dilly-Bag (Plate xv, fig. m). A dilly-bag containing corms of *Scirpus littoralis*.

A.42138. Wooden Mallet (Plate xv, fig. n). *Wikmuŋkan* name *ɔ:ɻa*. It is used for beating corms after cooking them on coals. (It is shown in use in Plate iv, fig. a).

A.42139. FLAT CAKES OF SCIRPUS LITTORALIS (Plate xv, fig. f). They are ready for eating, rendered digestible by roasting and beating.

A.42125. DILLY-BAG (SAMPLE) (Plate xv, fig. a). Bag filled with shells to illustrate falling open of mouth due to position of handles, which allows it to lie flat on back; also gives easy entrance of hand when gathering roots and mud shells.

A.42126-42127. MUSSEL SHELLS (GELOINA COAXANS) (Plate xv, fig. b-c). *Wikmuŋkan* name, *ku:mala.* Shells dug out of the mud of the mangrove-clad creek-beds by women. These mussels are eaten and shells used for spoons, scrapers, etc.

A.42128. BAILER SHELL (MELO AMPHORUS) (Plate xv, fig. e). *Wikmuŋkan* name, *weḷa.* This specimen is used for bailing water out of canoes and wells, for drinking, as a cooking vessel, and for heating gum, etc.

A.42130. PEARL SHELL OYSTERS (PINCTADA MARGARITIFERA) (Plate xv, fig. h, j, also Text fig. 3f). *Wikmuŋkan* name, *aṭuwa.* They are found on the Gulf shore. The fish is used for eating and the shell for making necklets.

A.42131. NECKLET MADE FROM RECTANGULAR PIECES OF PINCTADA MARGARITIFERA (Plate xv, fig. o). *Wikmuŋkan* name, *aṭuwa.* Rectangular pieces of shell ground and shaped by pieces of hardwood and shell-grit and threaded on string.

A.42132. SPIRAL SHELL DRILL (TURRITELLA CEREA) (Plate xv, fig. i). *Wikmuŋkan* name, *ta:'ɔnta.* This specimen is used for drilling holes in rectangular pieces of pearl shell.

A.42133. SHELL DRILL (Plate xv, fig. p, also Text fig. 3a). A stick with *Turritella* shell lashed obliquely on to end—so that drilling point is at exact centre of spinning stick when twisted between hands as in making fire; used to bore holes in pearl shell for threading pieces into necklet.

A.42111-112. CIRCLETS (TWINE OVERWOUND) (Plate xvi, fig. o-p). *Wikmuŋkan* name, *maŋka pi:lan* (girdles). These are worn by women for special occasions around abdomen or over neck and under arm, doubled over to required size.

A.42108 and A.42158. CIRCLETS (TWINE AND JABIRU-DOWN) (Plate xvi, fig. l). These are made of white fluffy jabiru-down woven into twine, folded to required size, worn by women around abdomen *(maŋka pi:lan)* or over neck and under arm *(mankoiya buntyaka)* on special occasions.

BETROTHAL RING (TWINE OVERWOUND) (Text fig. 4a). This specimen is placed over tuft of man's hair by a woman who promises her daughter.

A.42113-114. CIRCLETS (TWINE OVERWOUND) (Plate xvi, fig. q-r). *Wikmuŋkan* name, *mankoiya buntyaka.* These overwound twine circlets are made to fit

over neck and under arm and worn by women, chiefly for mourning purposes (optional) and dances.

A.42107. Necklet (widow's) (Plate xvi, fig. k). *Wikmuŋkan* name, *mankoiya wantya-wantanaka,* i.e., necklet of a bereaved woman. String of overwound twine, worn by widows round neck, fastened in front and crossed behind; beeswaxed ends hanging down at back; compulsory use; must be kept and worn always till mourning ends.

A.42106. Necklet (widow's) (Plate xvi, fig. j; also Text fig. 4d). *Wikmuŋkan* name, *mankoiya wantya-wantanaka.* It is worn as above, beeswax ends are studded with scarlet *Abrus* seeds with strings at one end for fastening for extra security.

A.42105. Necklet (baby's) (Plate xvi, fig. i; also Text fig. 4c). *Wikmuŋkan* name, *mankoiya wantya-wantanaka.* This specimen shows manner of attaching navel cord to pendant (beeswax ornamented with yellow orchid bark strips), tied round baby's neck on occasion of presentation to its father by its mother; navel cord must always be kept safely. String replaces navel cord in this specimen.

A.42109-110. Necklets (lover's) (Plate xvi, fig. m-n). *Wikmuŋkan* name, *maneŋka.* These specimens are fine knotted or plain strands of string, dyed red; sent by woman to her lover by his half-sister, who arranges a meeting place. (See also Text fig. 4b.)

A.42100-101. Girdles (orchid bark) (Plate xvi, fig. a-b). *Wikmuŋkan* name, *maŋka pi:lan.* These are strips of orchid bark *(Dendrobium johannis)* burned in fire to accentuate yellow colouring; woven or plaited by women into a flat band on twine base; worn by women around abdomen on special occasions or as crossovers; sometimes worn in shorter lengths round head, arm or leg by men.

A.42102-103. Girdles (grass bugle) (Plate xvi, fig. c-d). *Wikmuŋkan* name, *maŋka pi:lan mankɔiya buntyaka.* They have hollow stems of grass of various sizes strung on twine; made in single, double, or multiple strands; fastened by strings at both ends or a loop at one end and strings at other; or by tying string into doubled-over girdles; worn by women on special occasions around abdomen *(maŋka pi:lan)* or over neck and under arm *(mankoiya puntyaka)* in short lengths or folded.

A.42103. Widow's String (grass bugle) (Plate xvi, fig. d). This specimen is worn hanging down the back from head for mourning.

A.42104. Necklet (grass bugle) (Plate xvi, fig. e). *Wikmuŋkan* name *mankoiya.* This is similar to the above specimen and is worn around neck by women.

A.42115. NECKLET (NAUTILUS) (Plate xvi, fig. s). *Wikmuŋkan* name, *wa:taku:pa.* Pierced rectangular pieces of pearly shell *(Nautilus pompilius)* threaded on string, twisted so as to show pearly flat side of shell; worn as head band or necklet by men and women; usually by women for mourning dances.

A.42117. NECKLET (SHELL) (Plate xvi, fig. y). *Wikmuŋkan* name, *welmanya.* A necklet made of small shells *(Oliva ispidula)* used by E. coast tribes; sometimes used in Gulf area as necklets, or cross-over and under arm, or around abdomen.

A.42121. ABRUS PRECATORIUS (SAMPLE) (Plate xvi, fig. g). These seeds are used for decoration purposes, e.g., on firestick sheaths and spear-throwers; nowadays are threaded to make necklets, etc., while green, using needle and cotton.

A.42122. CIRCLET (ABRUS) (Plate xvi, fig. f). Seeds of *Abrus precatorius* threaded when soft on cotton with needle. This string is popular for use on ceremonial occasions; worn by women over neck and under arm or as necklets; probably a modern adaptation of an old use of decorative seed, due to introduction of needle-and-cotton.

A.42116. HEADBAND (OPOSSUM'S FUR AND TWINE) (Plate xvi, fig. x). A worn specimen of man's headband made of twine with opossum fur interwoven.

A.42120. NECKBAND OR COLLAR (Plate xvi, fig. h). It is made of pliable wood bent in a circle, covered with beeswax and studded with *Abrus* seeds. It is said to be worn by men; a unique specimen; not indigenous to Gulf areas.

A.42118-119. ARMLETS (PANDANUS) (Plate xvi, fig. t-u). *Wikmuŋkan* name, *kɔiya buntaka.* These armlets are made of slips of pandanus palm leaf *(kuntyan),* sewn together at ends by passing stripped ends of leaf through other end of band and knotting. They are worn chiefly by men for the dance.

A.42123. MESSAGE STICK (Plate xvi, fig. v). *Wikmuŋkan* name, *ma:ka.* The message is indicated by incisions on stick; telling recipient to come up Archer River and bring his wife; division into two parts—smaller part denotes wife.

A.42124. MESSAGE STICK (Plate xvi, fig. w). *Wikmuŋkan* name, *ma:ka.* The incisions indicate how many sticks of tobacco recipient is asked to deliver to owner of message stick.

A.42074. BULLROARER (Plate xvii, fig. b). *Wikmuŋkan* name, *moiya.* This specimen represents young girl entering puberty *(kɔman manya),* small leaf-like flat smooth wooden object fastened to string for swinging. It is swung by initiates at end of first part of initiation *(U:tyanam)* ceremony. Vide Oceania, vol. vi, No. 1, pp. 68-93; plate 2 (A and B), p. 68; pp. 76-83.

A.42073. Bullroarer (Plate xvii, fig. c). *Wikmuŋkan* name, *pakapaka.* A similar object, larger and heavier, painted red and white, represents fully-matured girl *(kɔman)*; swung by initiates at end of *U:tyanam* ceremony. Vide Oceania, vol. vi, p. 68, plate 2, and pp. 76-83.

A.42075. Bullroarer (female) (Plate xvii, fig. d). *Wikmuŋkan* name, *moipaka.* This specimen is similar to above specimen but is larger, red with white splotches. It represents a married woman *(wantya pi:'an),* who has as yet no child; swung by fully-grown man *(mantaiyan)* to awaken interest of *wantya pi:'an.* Vide Oceania, vol. vi, p. 69 (3-4), also pp. 89-92.

A.42072. Bullroarer (male) (Plate xvii, fig. a). *Wikmuŋkan* name, *moipaka.* A phallic-shaped specimen; represents husband of above. Vide Oceania, vol. vi, p. 69 (3-4) and pp. 89-92.

Bullroarer (female). It is striped red and white, similar to above (female), and represents married woman with child; swung at childbirth drama. Vide Oceania, vol. vi, plate III B.

A.42077. Figurine (Plate xvii, fig. f). A wax-modelled figure of newly-born baby (male), complete in all essentials. Penis and pubic hair are well shown. This specimen is used in myth and drama of creation of first child; shown (Plate v, fig. f) lying on abdomen of man (representing a woman). Vide Oceania, vol. vi, No. 1, p. 92, Plate III A.

A.42076. Phallus (wooden) (Plate xvii, fig. e). It is painted red and white and used (Plate v, fig. d) in creation ritual of bony-bream *pulwaiya Wɔlkɔlan* (*Wikmuŋkan* tribe, Archer River). Vide Oceania, vol. vi, No. 1, p. 93, Plate I; also pp. 66-68.

A.42078-79. Phallic Symbols (Plate xvii, fig. g-h). These symbols are made of painted strips of pandanus palm bark strung together; worn suspended from the waist. Part of *Wikkalkan* drama of the Two Cockatoos and the *moipaka.* Vide Oceania, vol. vi, No. 1, pp. 84-89.

A.42080. Symbolic Fish (Plate xvii, fig. i). This specimen is made of a wad of ti-tree bark to represent a fish; held in mouth of man (Plate vi, fig. b) representing bird preying on fish on edge of water hole in drama belonging to that clan.

A.42245. Firestick, Sheath. A sheath for firesticks; two hollow cane tubes for holding firesticks, fastened with bark strips of orchid *(Dendrobium johannis)* burnt yellow in fire; sheath held at end by knob of black beeswax studded with scarlet seeds of *Abrus precatorius*; colours of fire, black, yellow and red. This specimen is from Gulf of Carpentaria.

A.42244. FIGURED BASE AND FIRESTICKS (2). They have a flat base carved and coloured; represents woman's figure, into eyes of which firesticks are bored to produce fire; from Cairns-Port Douglas area, N.Q.

A.42243. FIGURED BASE AND FIRESTICKS. The sticks are fastened to base for carrying; from Cairns-Port Douglas area, N.Q.

A.42246. FIRESTICKS (2) AND TINDER. The flattened base is said to be female into which the rounded stick, said to be male, is bored to make fire. From California, U.S.A., Karuk Indians, Klamath River.

SPECIMENS FROM CAIRNS-PORT DOUGLAS AREA.

A.42201. FIGHTING SHIELD. This specimen has boomerang design, comes from the *Gu:nänni* tribe of Mitchell River, N.Q. Published in "Art in Australia," May, 1935, p. 57, fig. 1.

A.42202. FIGHTING SHIELD. Mopoke design from *Gu:nänni* tribe of Mitchell River, N.Q. Published in "Art in Australia," May, 1935, p. 57, fig 2.

A.42203. FIGHTING SHIELD. Initiation markings, *Gu:nänni* tribe, Mitchell River, N.Q. Published in "Art in Australia," May, 1935, p. 57, fig. 3.

A.42204. FIGHTING SHIELD. Boomerang design, from *Gu:nänni* tribe, Mitchell River, N.Q. Published in "Art in Australia," May, 1935, p. 57, fig. 4.

A.42205. SMALL CEREMONIAL SHIELD *(bi:gɔ:rn gidgar)*. Ink fish *(dyu:-dugan)* design, *Kuŋgä:ndyi* (often *Kuŋgändyi*) tribe, Yarrabah, Cairns, N.Q. *Mira Ka:bara* ground, Fitzroy Island. "Art in Australia," p. 58, fig. 1.

A.42206. SMALL CEREMONIAL SHIELD *(bi:gɔ:rn gidgar)*. Boomerang *(waŋal)* design, from *Yiddindyi* tribe, *Mira Gu:dyuŋ* (near Reeve Creek) ground. Published in "Art in Australia," p. 58, fig. 2.

A.42207. SMALL CEREMONIAL SHIELD *(bi:gɔ:rn gidgar)*. Tree grub *(minderi)* design, *Yiddindyi* tribe, *Mira Gu:dyuŋ* (near Reeve Creek). Published in "Art in Australia," p. 58, fig. 3.

A.42208. SMALL CEREMONIAL SHIELD *(bi:gɔ:rn gidgar)*. Leaves of scrub tree bearing edible fruit *(bi:win)*, from *Kuŋgä:ndyi* tribe, *Mira Ka:bara* (Fitzroy Island). Published in "Art in Australia," p. 58, fig. 4.

A.42209. LARGE FIGHTING SHIELD *(bi:go:rn)*. Turtle *(birikala)* design, *Yiddindyi* tribe, *Mira Baki*. Published in "Art in Australia," p. 59, fig. 1.

A.42210. LARGE FIGHTING SHIELD *(bi:go:rn)*. Scorpion *(dumbun)* design, *Yiddindyi* tribe, *Mira Baki* ground. Published in "Art in Australia," p. 59, fig. 2.

A.42211. LARGE FIGHTING SHIELD *(bi:go:rn)*. Matchbox bean pod *(dyuŋai)* design, *Kuŋgä:ndyi* tribe, *Mira Wungula* ground. Published in "Art in Australia," p. 59, fig. 3.

A.42212. Large Fighting Shield *(bi:go:rn)*. Drops of blood and scratches *(gunaugu)* design, scratches made on nose and drops of blood thus obtained and used as an adhesive in decoration during ceremonies; *Yiddindyi* tribe, *Mira Baki* ground. Published in "Art in Australia," p. 59, fig. 4.

A.42213. Small Ceremonial Shield *(bi:gɔ:rn gidyar)*. Scorpion *(dumbun)* design, *Yiddindyi* tribe from Yarrabah, Cairns, N.Q. *Mira ŋumbundyi* ground. Published in "Art in Australia," p. 60, fig. 1.

A.42214. Small Ceremonial Shield *(bi:gɔ:rn gidyar)*. Salmon *(kuiman)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Wungula* (mission site) ground. Published in "Art in Australia," p. 60, fig. 2.

A.42215. Small Ceremonial Sword *(ba:gɔ:r gidyar)*. Salmon *(kuiman)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Wungula* (mission site) ground. Published in "Art in Australia," p. 60, fig. 3.

A.42216. Small Ceremonial Shield *(bi:gɔ:rn gidyar)*. Leaves of tree used in making boomerang *(dyära dyira)*, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q. Published in "Art in Australia," p. 60, fig. 4; cf. also p. 62 VI (boomerang).

A.42217. Small Ceremonial Shield *(bi:gɔ:rn gidyar)*. Tomahawk *(kälbun)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Ka:bara* ground. "Art in Australia," p. 61, fig. 1.

A.42218. Small Ceremonial Shield *(bi:gɔ:rn gidyar)*. Bark water bag *(dɔgobil)* design, *Yiddindyi* tribe, Yarrabah, Cairns, N.Q., *Mira ŋumbundyi*. "Art in Australia," p. 61, fig. 2.

A.42219. Small Ceremonial Shield *(bi:gɔ:rn gidyar)*. Starfish *(dyära madyai)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Ka:bara* ground. "Art in Australia," p. 61, fig. 4.

A.42220. Small Ceremonial Shield *(bi:gɔ:rn gidyar)*. Nettle-sting curing plant *(ka:ndɔ:r)*, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Baki* ground. "Art in Australia," p. 61, fig. 5.

A.42221. Ceremonial Paddle *(milgara)* used in paddle dance. Crocodile *(kanyara)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Baki* ground. "Art in Australia," p. 62, plate i, fig. 1.

A.42222. Ceremonial Paddle *(milgara)* used in paddle dance. Sawshark *(dyägara)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Baki* ground. "Art in Australia," p. 62, fig. 2.

A.42223. Ceremonial Paddle *(milgara)* used in paddle dance. Nettle-sting curing plant *(ka:ndɔ:r)*, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Baki* ground. "Art in Australia," p. 62, fig. 3.

A.42224. CEREMONIAL PADDLE *(milgara)* used in paddle dance. Rainbow-serpent *(kudyu kudyu) design, Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Baki* ground. "Art in Australia," p. 62, fig. 4.

A.42225. CEREMONIAL PADDLE *(milgara)* used in paddle dance. Lawyer cane *(kuɨ:gi)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Baki* ground. "Art in Australia," p. 62, fig. 5.

A.42226. CEREMONIAL POLE *(wɔrripa gidyar).* Rainbow-serpent *(kudyu kudyu)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q. "Art in Australia," p. 62, plate ii, fig. 1.

A.42227. CEREMONIAL SWORD *(ba:gɔ:r gidyar).* Rainbow-serpent *(kudyu kudyu)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q. "Art in Australia," p. 62, plate ii, fig. 2.

A.42228. CEREMONIAL PADDLE *(milgara gidyar).* Rainbow-serpent *(kudyu kudyu)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q. "Art in Australia," p. 62, plate ii, fig. 3.

A.42229. CEREMONIAL CROSS—BOOMERANG OR TWIRLER *(yintyɔ:r gidyar),* spun between hands in whirlwind dance. Scorpion *(dumbun)* design, *Yiddindyi* tribe, Yarrabah, Cairns, N.Q., *Mira Ŋumbundyi* ground. "Art in Australia," p. 62, plate vi (first step).

A.42230. CEREMONIAL CROSS—BOOMERANG OR TWIRLER *(yintyɔ:r gidyar),* spun between hands in whirlwind dance. Comet *(dyiri:bara)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Ka:bara* ground. "Art in Australia," p. 62, plate vi (second step).

A.42231. CEREMONIAL CROSS—BOOMERANG OR TWIRLER *(yintyɔ:r gidyar),* spun between hands in whirlwind dance. Star *(kauwai)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q. "Art in Australia," p. 62, plate vi (second step, right).

A.42232. CEREMONIAL CROSS—BOOMERANG OR TWIRLER *(yintyɔ:r gidyar),* spun between hands in whirlwind dance. Kingfish *(tyäla:da)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Wungula* ground. "Art in Australia," p. 62, plate vi (third step).

A.42233. CEREMONIAL CROSS—BOOMERANG OR TWIRLER *(yintyɔ:r gidyar),* spun between hands in whirlwind dance. Bark water bag *(dogobil)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q. "Art in Australia," p. 62, plate vi (fourth step).

A.42234. CEREMONIAL CROSS—BOOMERANG OR TWIRLER *(yintyɔ:r gidyar),* spun between hands in whirlwind dance. Matchbox bean pod *(dyuŋai)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q. "Art in Australia, p. 62, plate vi (fourth step).

A.42235. CEREMONIAL CROSS—BOOMERANG OR TWIRLER *(yintyɔ:r gidyar),* spun between hands in whirlwind dance. Salmon backbone *(kuiman)* design,

Kuŋgä:ndyi tribe, Yarrabah, Cairns, N.Q. "Art in Australia," p. 62, plate vi (fourth step).

A.42236. Ceremonial Cross—Boomerang or Twirler *(yintyɔ:r gidyar)*, spun between hands in whirlwind dance. Sawfish *(dyägara)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q., *Mira Baki* ground. "Art in Australia," p. 62, plate vi (fifth step).

A.42237. Ceremonial Cross—Boomerang or Twirler *(yintyɔ:r gidyar)*, spun between hands in whirlwind dance. Edible palm leaf and fruit *(dyaiyɔ:r)* design, *Kuŋgä:ndyi* tribe, Yarrabah, Cairns, N.Q. "Art in Australia," p. 62, plate vi (fifth step).

A.42238. Boomerang. Plain stick with lighting attachment, used to amuse children by spinning at night-time.

A.42239. Ceremonial Sword *(ba:gɔ:r gidyar)*. Scorpion *(dumbun)* design, *Yiddindyi* tribe, Cairns, N.Q., *Mira Ŋumbundji* ground. "Art in Australia," p. 67, plate iii, fig. 2.

A.42240. Ceremonial Boomerang. Scorpion *(dumbun)* design, *Yiddindyi* tribe, Cairns, N.Q., *Mira Ŋumbundji* ground. "Art in Australia," p. 67, plate iii, fig. 3.

A.42241. Ceremonial Spearthrower *(milai)*. Scorpion *(dumbun)* design, *Yiddindyi* tribe, Cairns, N.Q., *Mira Ŋumbundji* ground. "Art in Australia," p. 67, plate iii, fig. 4.

A.42242. Old Fighting Sword *(ba:gɔ:r)*. Found by early settlers on Daintree River by the late Mr. Osborn, senior. "Art in Australia," p. 68, plate v, fig. 2.

A.42249. Pair of Tapping Sticks, used to keep time in dances. *Kuŋgä:ndyi* tribe, Cairns area, N.Q.

OTHER SPECIMENS IN THE McCONNEL COLLECTION

(at present on loan to Sydney University).

One Fish Hook from Cairns area.

Axe. It is a large, unpolished and rehafted axe from the Cairns area and found by early settlers in Douglas Creek; smoothed by action of water. Rehafted by man of this area in old style with lawyer-cane and beeswax.

Axe. A small, polished and rehafted specimen from the Cairns area. The stone is not indigenous; axe picked up on beach; said to be a child's axe.

Axe. Unhafted specimen from Daintree River, N.Q.

Axe. Unhafted specimen from Upper Brisbane River, found by the late W. A. Munro on Braemar farm, Toogoolawah.

ONE GRINDING STONE AND GRINDER. This specimen was found by the late W. A. Munro on Braemar farm, Upper Brisbane River, and is of a type used for grinding Moreton Bay chestnuts into flour.

ONE COUP DE POING. This specimen is Mousterian and from Dordogne River, France. Dug out of rock shelter by U. H. McConnel when working with American School of Prehistory.

SPEAR HEAD. This specimen is made from glass insulator; found in Central Australia and presented to U. H. McConnel by a Central Australian resident.

SHIELDS. Four shields from Mitchell River, figured in "Art in Australia," plate i, fig. 1-4. (A.42201-42204.) The others listed above have not as yet been allotted South Australian Museum numbers.

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EXPLANATION OF PLATES.

Plate i, a-d.

a. Archer River family; note the artificially distended ear lobe for wearing ear ornament.

b. Sewing the prow of an Archer River bark canoe with cane and wallaby bone stiletto; sheet of bark is folded in two and held by stakes.

c. Archer River woman in a bark canoe with dog and her husband's spears, paddling along the mangroves.

d. Kendall River man paddling a sewn-bark canoe, using mangrove wood paddle.

Plate ii, a-d.

a. Old woman returning to camp, yamstick in hand; on her head is a dilly-bag full of corms, topped by a bundle of firewood.

b. Old man repairing a spear point by using a palette to smooth on it hot gum while moulding the join.

c. Boy with play spears of bamboo, and small girl with abdominal string.

d. Women coming up out of lagoon with dilly-bags full of water-lily seed-pods on their heads. Note habitually worn abdominal strings.

Plate iii, a-d.

a. Women digging with their hands for *Scirpus* corms in mud of a swamp near Kendall River.

b. Women gathering water-lily *(Nymphaea)* seed-pods in a lagoon near the Holroyd River.

c-d. Women camped in sandy river bed of the Holroyd making "grass" baskets of *Xerotes* blades.

Plate iv, a-d.

a. Woman roasting rush-corms on a fire; another using a mallet to soften when roasted.

b. Mother with new-born babe, still in seclusion, attended by other women; note dilly-bag of roots on stick, feather fan, and shell dish with water.

c. Woman netting a string bag; note string tied around deformed leg, also about wrist, to induce strength.

d. Mother and old woman attendant in a secluded spot with new-born baby in a bark cradle.

Plate v, a-f.

a. Drama of the first birth; man swinging the female *moipaka* or bullroarer.

b. The oyster *pulwaiya* goes down into his *auwa*, after being speared by a shark; he is attended by his younger brother, who catches lice in his hair; the elder brother is gradually assuming the sessile position of the oyster.

c. Archer River drama of the first death.

d. Increase ritual of bony-bream; this fish *pulwaiya* stands, riddled with the spears of his slayers, while a suppliant fans him and manipulates a wooden phallus.

e. Wax figurine of first man child lying on abdomen of first mother; the clasped hands symbolize continuity through birth.

f. Bird *pulwaiya* on edge of waterhole, with a fish (of bark) in its mouth; see also Plate vi, fig. b.

Plate vi, a-f.

a. Dramatic representation of oyster *pulwaiya;* the performer has his nose flattened by tying; the face is covered with white ash pigment and the mouth propped open with a stick to represent the oyster shell opened for eating.

b. Man representing bird *pulwaiya* holding a fish (of bark) in his mouth.

c. Mbu: the ghost, haunting the camp after death; body tied to pole for mummification.

d. Women painting their bodies with clay for a mourning dance.

e. Mbu: the ghost, representing the first corpse to be mummified, tied up in bark and supported on forked sticks.

f. Tyi:t, the hawk, his brother, making a mourning dance for Mbu:, the ghost, during the first inauguration of funeral rites.

Plates vii-xvii.

Ethnographic objects from Kendall, Holroyd and Archer River areas. For descriptions see text at pages 23 *et seq.*

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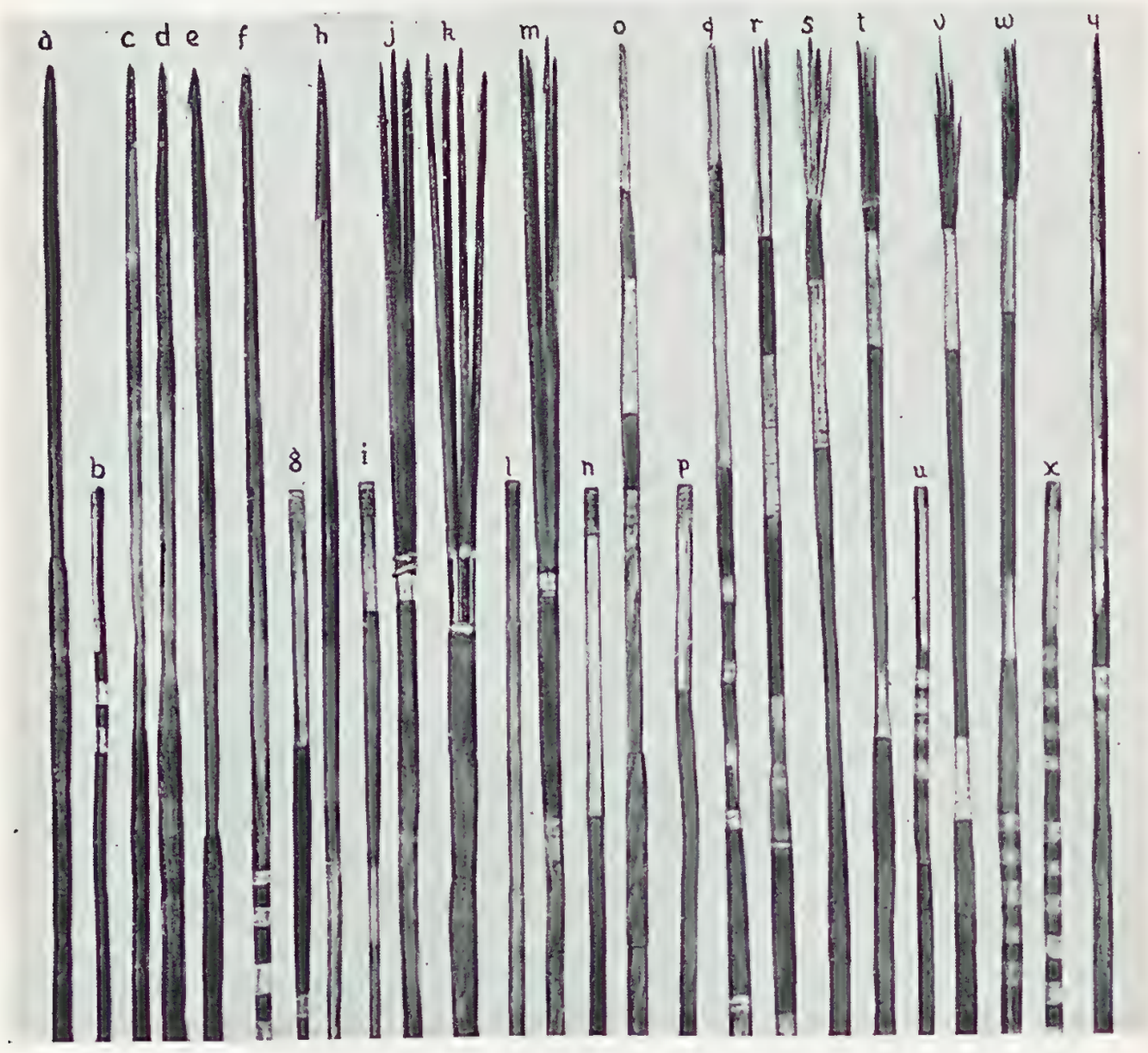
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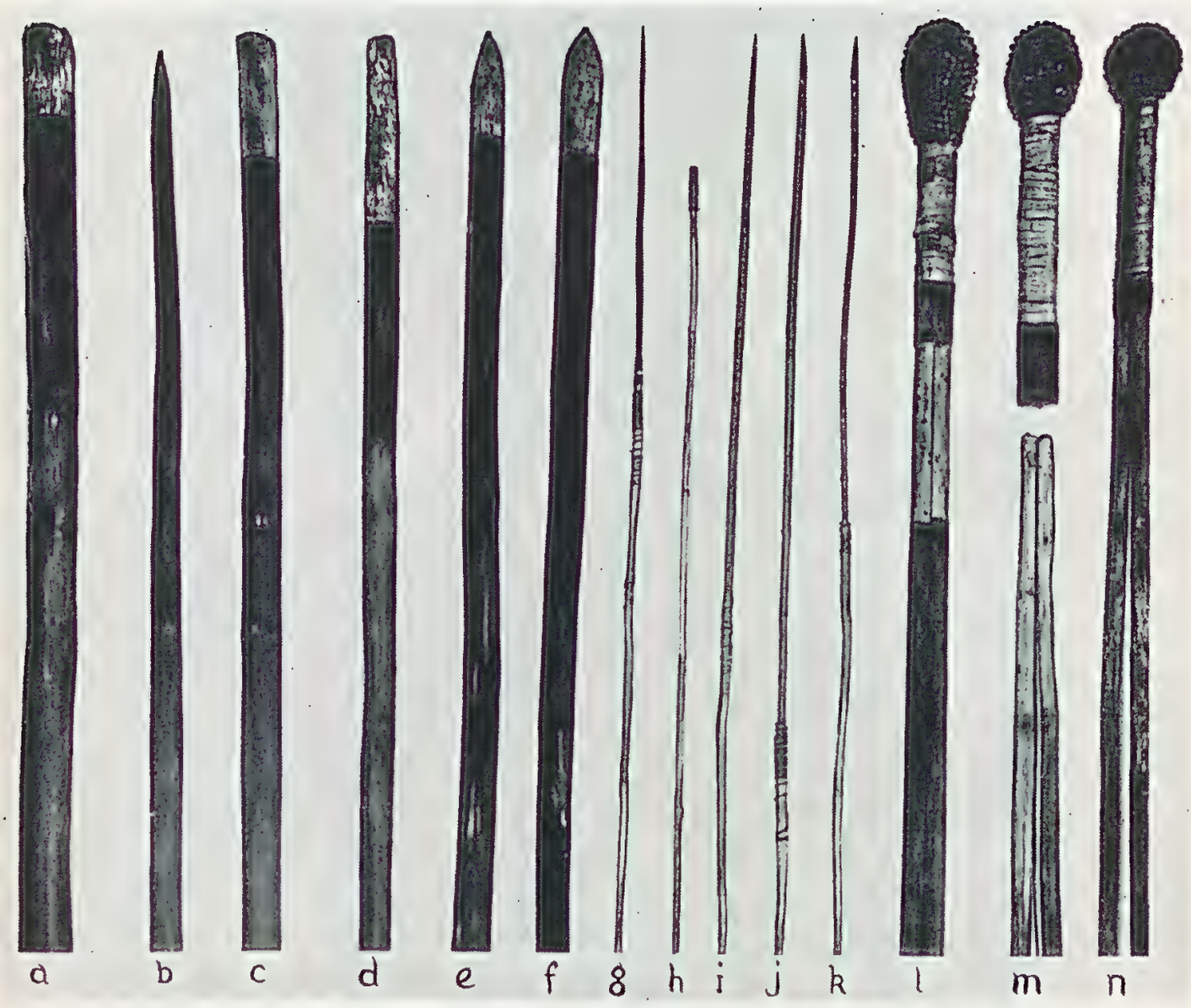
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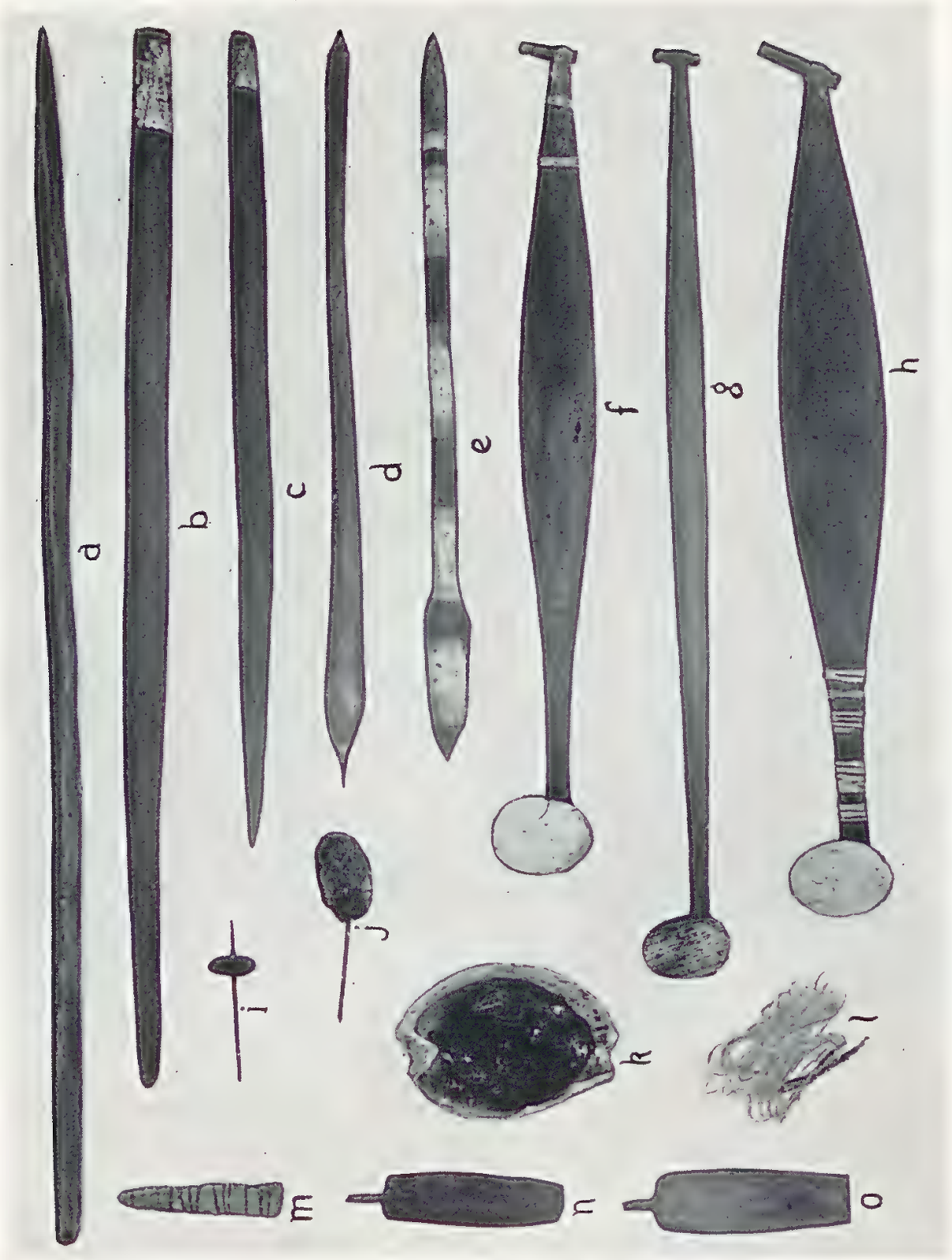
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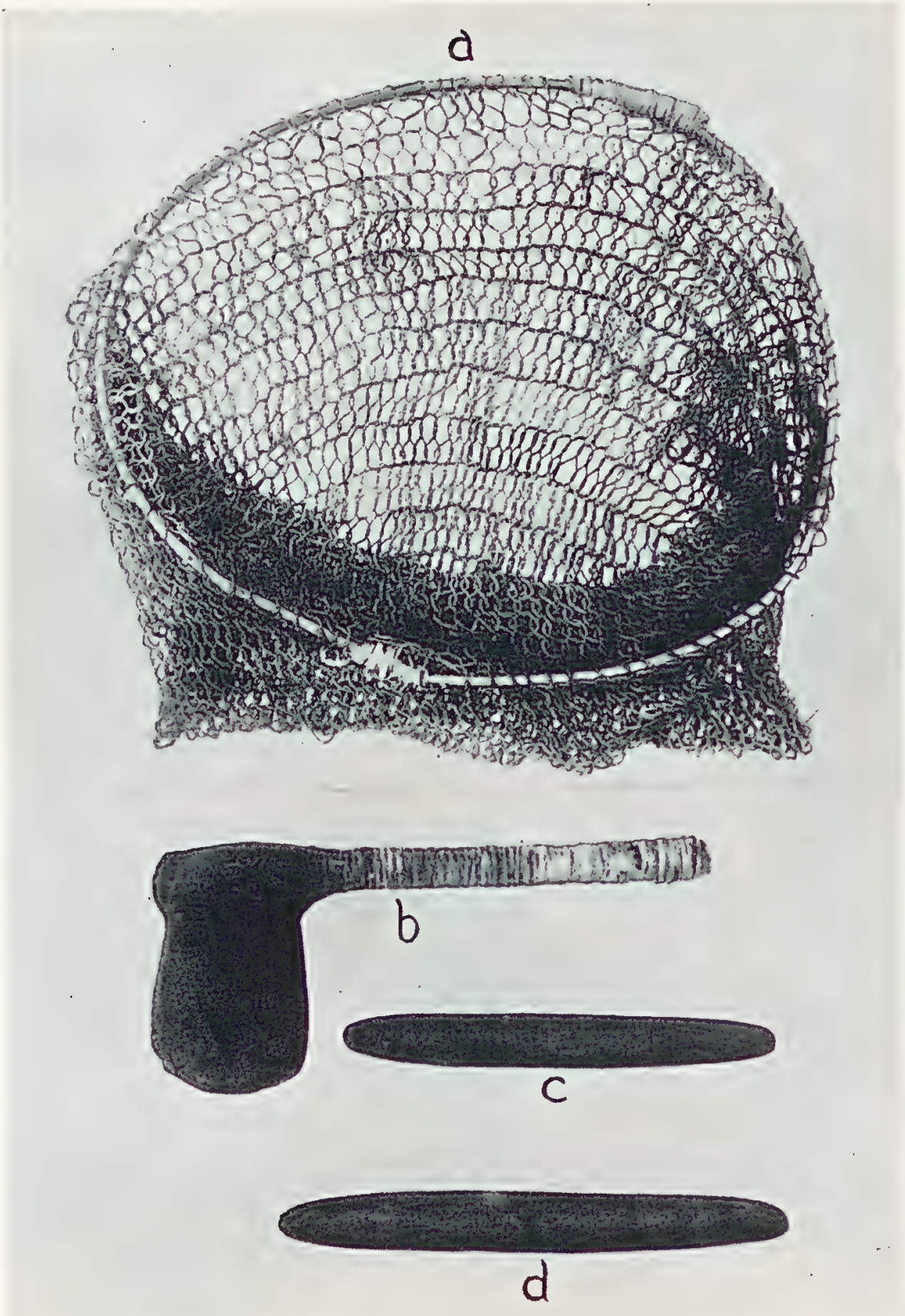
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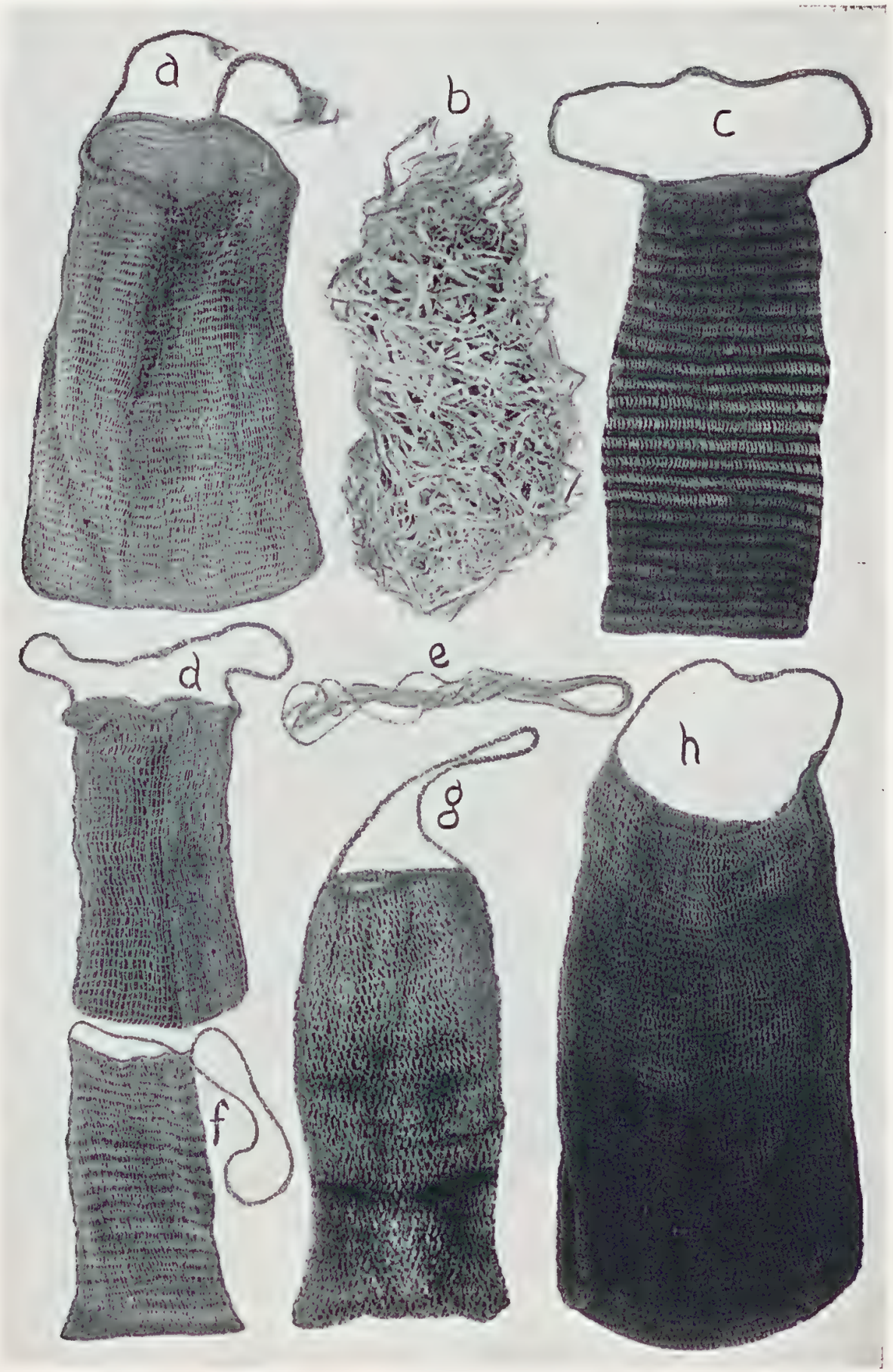
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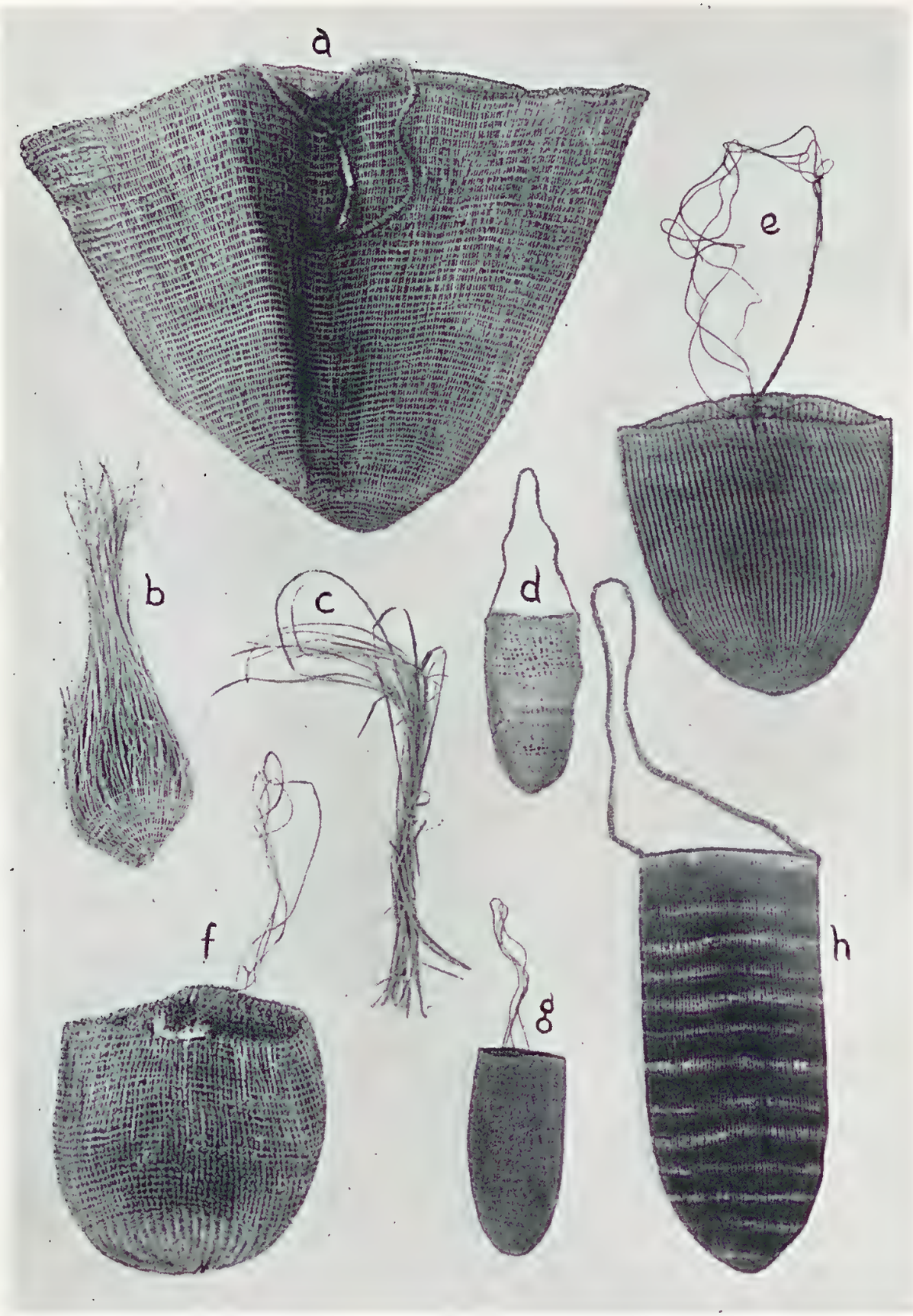
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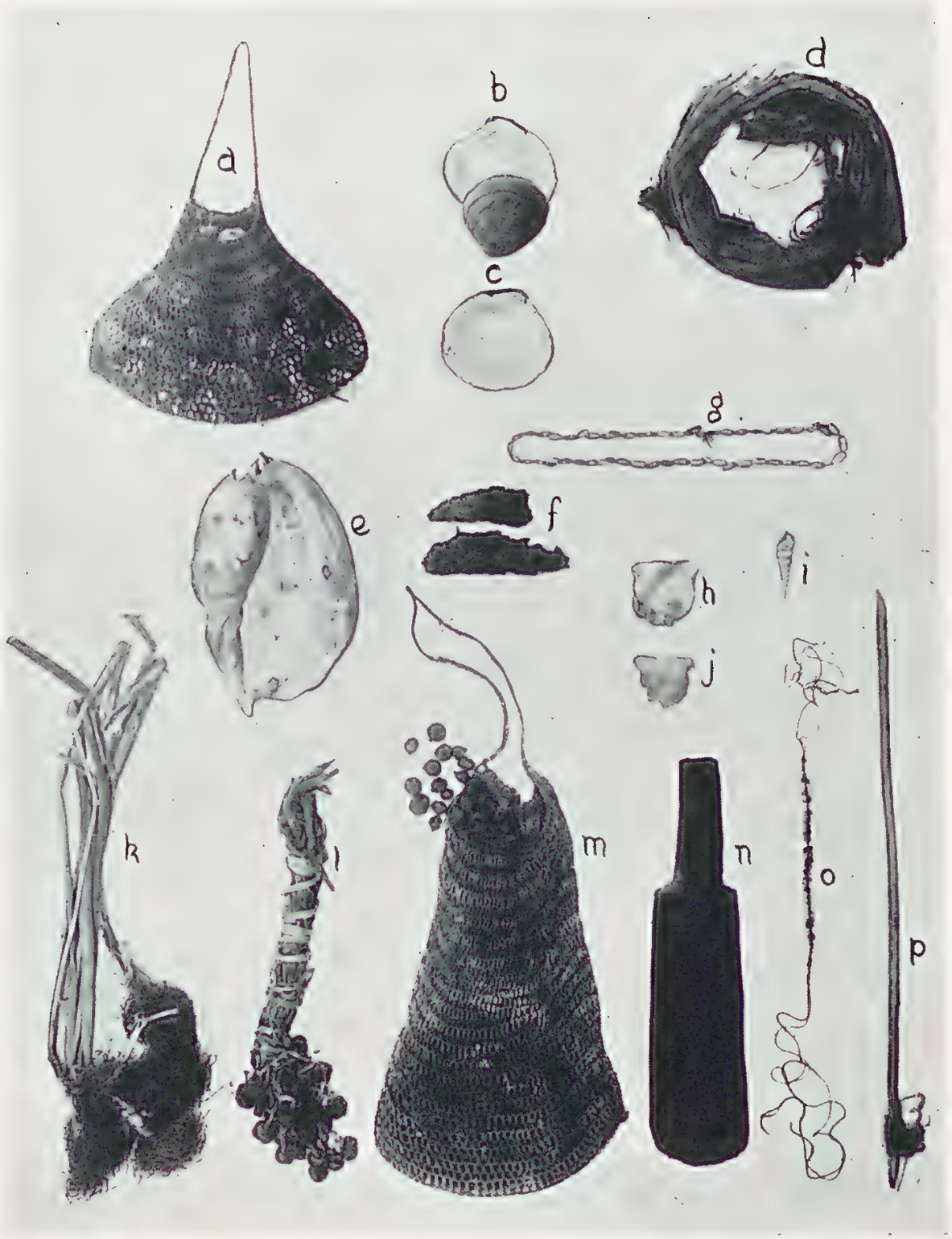
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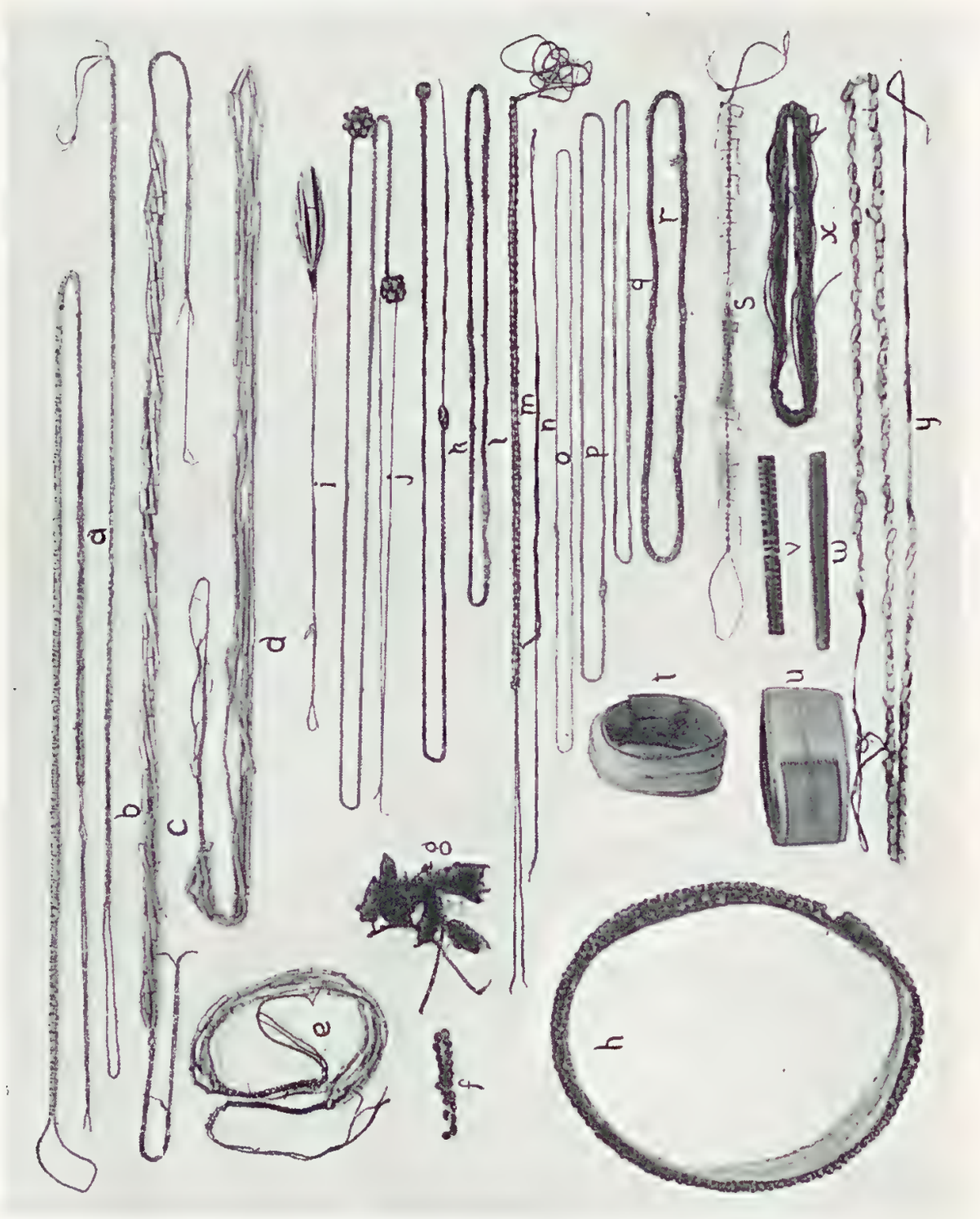
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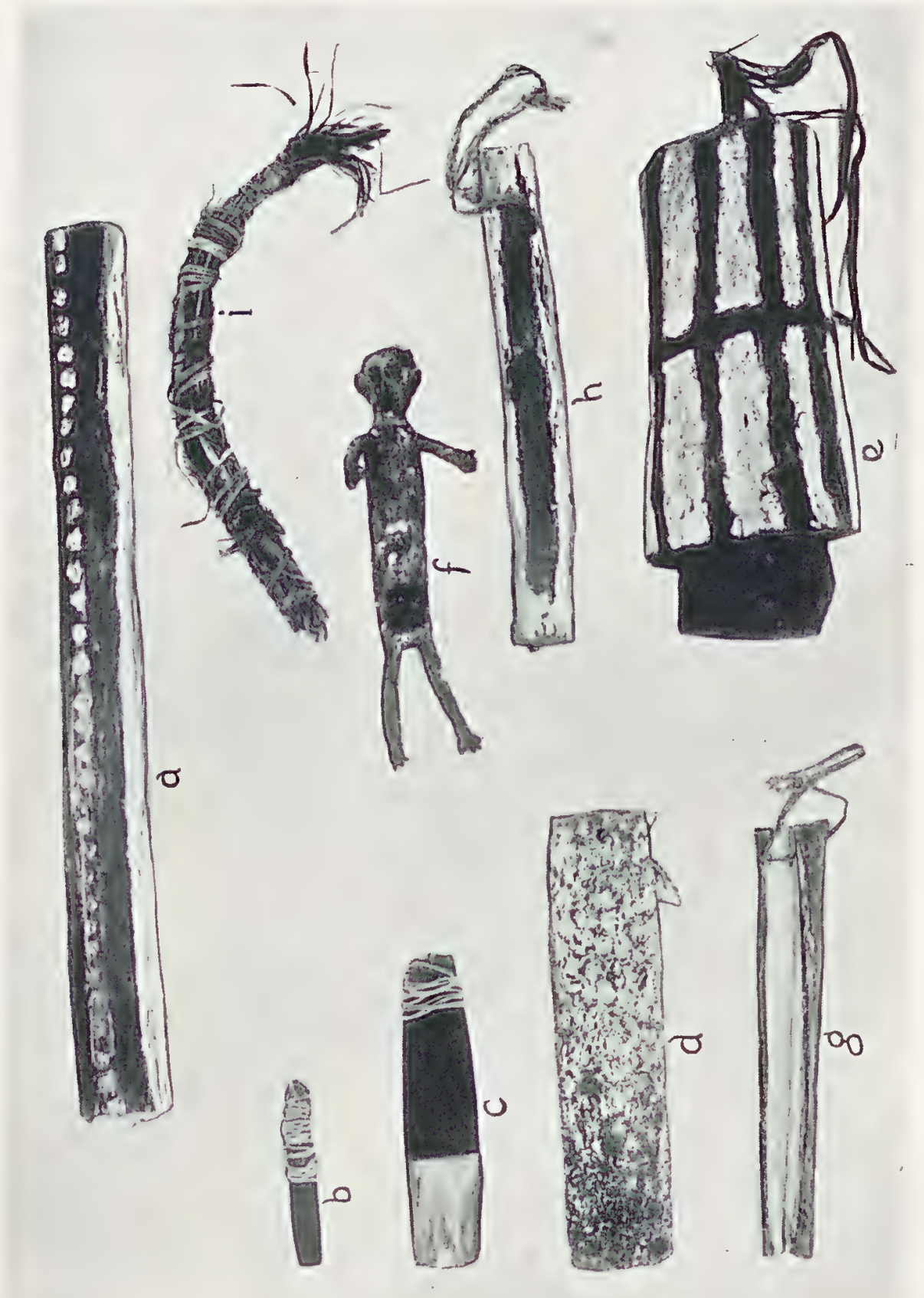
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NEW RHOPALOCERA, AND A LIST OF SPECIES FROM THE GRAMPIAN MOUNTAINS, WESTERN VICTORIA

By NORMAN B. TINDALE, B.Sc., South Australian Museum.

Plates xviii-xxi and text fig. 1-4.

SUMMARY.

Two new races of *Heteronympha banksii, H. b. nevina* from Mt. Rosea, Western Victoria, and *H. b. mariposa* from the Macpherson Range, South Queensland, are described, also a new race of *H. solandri, H. s. angela* from Mt. Rosea.

Pseudalmenus chlorinda fisheri is described as new from Mt. Victory—the first record of a form of this Tasmanian and Eastern mountain species in Western Victoria.

Hesperilla crypsargyra lesouefi is also described as new from Mt. William.

Several life histories and locality records are given, together with a list of 39 species taken in the vicinity of the Grampians.

The sword grass *Gahnia microstachya Bentham,* foodplant of *Hesperilla crypsargyra,* and a grass (*Tetrarrhena acuminata* R. Brown) are recorded for the first time from Western Victoria and the Grampians.

The significance is discussed of the presence of these newly recorded species in terms of climate and geographical distribution.

INTRODUCTION.

Messrs. B. B. Given, J. C. LeSouef and the writer spent from 8-19th November, 1950, collecting in the Grampians and vicinity. The author again collected in the Grampians from 24-30th November, 1951, with Messrs. R. H. Fisher and J. C. LeSouef; Fisher and he also visited the Little Desert and Kiata. A third visit was made to the Grampians, with A. J. Tindale, from 25-28th December, 1951. The subalpine summit plateau of Mt. William (3,829 ft.) was collected over on 13th and 27th November and 27th December; owing to bad weather none of the visits to the summit proved to be productive. In general the 1951 season was poor, possibly a result of the unprecedented heat of the previous summer.

These visits to the Grampians area have yielded several new records as well as five new forms. Of these *Heteronympha penelope maraia* Tindale (1952) is described elsewhere, the others are presented herein.

HETERONYMPHA BANKSII BANKSII (Leach) 1814.

Plate xviii, fig. c-d; plate xix, fig. h.

Hipparchia banksii Leach, 1814, i, p. 28, pl. 10, fig. 1-2.

Heteronympha affinis Lucas, 1890, p. 1,065.

Heteronympha banksi Waterhouse and Lyell, 1914, p. 38, fig. 103-105.

In the original account, this species was indicated only as from "New Holland." The early nineteenth century date implies that the first specimens must have been taken in New South Wales, either in the general vicinity of Sydney, or along the eastern coast. At that time other places where the species is known to occur had not been visited by Europeans. Therefore I nominate as the typical race that from the Sydney district. The male example figured herein is from Clifton, and the female from Roseville; both are places in the Sydney area. These may be regarded as topotypical. A pair depicted by Waterhouse and Lyell (1914, fig. 103-105) were from Wandin, Eastern Victoria. They appear to belong to the same race as Sydney examples. Lucas described very similar examples from Gippsland as *H. affinis*. His type pair are in the South Australian Museum (registered No. I. 14866). They are closely similar to Sydney examples, and it is unlikely they ever could be regarded as belonging to a separate race. If required the name *affinis* is available. It is possible Lucas when he described *H. affinis* did not have any authentically identified specimens of *H. banksii* for comparison; his remark that typical *H. banksii* had ten orange spots on the forewing seems hard to reconcile with any examples of the species.

H. b. banksii flies in February, March and April, being distributed on the Eastern Coast from Manning River, Central New South Wales, southward to Loch, Trafalgar and Wandin in Eastern Victoria. It is everywhere rare near the coast, becoming more common in the Blue Mountains and on the uplands of Eastern Victoria, at elevations of from one to three thousand feet.

HETERONYMPHA BANKSII NEVINA subsp. nov.

Plate xviii, fig. a-b, g; plate xix, fig. g, and text fig. 1.

Male. Wings above black with orange markings, also dull brown markings and suffusions near bases of both wings but not extending to tornus of hindwing; wing patterns generally as in the race *H. b. banksii* but with basal orange areas of hindwing large and separated from distal series only by a relatively narrow zig-zag intervening portion of black ground-colour; tornal

area orange, not uniformly suffused with brown as in other races; a single eyespot on hindwing similar in size to that in *H. b. banksii* but with outer brown ring less developed. Wings below generally as in *H. b. banksii* but apex of forewing with a sub-costal dark brown patch more conspicuously developed; basal half of hindwing of a bright yellowish-orange hue scarcely darker than basal-third of forewing; the outer suffused chocolate areas on hindwing have a rather conspicuous dark patch in the outer third. Wing length 27 mm., expanse 57 mm.

Female. Colour and markings above somewhat as in male but orange spots larger and separated only by narrow black interspaces; basal orange areas of fore- and hindwings very large; a small spot near termen of forewing white, instead of orange, as in male. Forewing beneath with basal areas orange, but distal spots yellow and surrounded with black, except near apex, where there is a chocolate-brown patch, and below it a small white spot. The hindwings have the basal half fawn with fine rich brown markings, the distal half is broadly blotched with the same brown colour, with a more smoky area midway between the eye spots. Wing length 26.5 mm., expanse 56 mm.

Loc. Western Victoria: Mt. Rosea at 1,000 ft. (Holotype, a male, 28th January, 1952, and allotype female, 13th February, 1952, and paratype male, registered No. I. 19089 in South Australian Museum, collected and presented by R. H. Fisher and the author; a paratype pair in the collection of R. H. Fisher). Three males and two females examined.

Members of this race differ from *H. b. banksii* in colour and markings. In particular the basal orange areas of the hindwing above are much larger, encroaching on the dark area separating the basal and distal series of orange spots and reducing it to about one-half the width found in *H. b. banksii.* The darker brown areas of hindwings beneath are much less evident and the basal half is of an orange to yellow colour little darker than on forewing. If only females of the two races had been known they would be considered separate species for the differences between them are marked. Examination of males suggests a closer relationship and they can only be regarded as very distinct races of one species.

The described examples were bred from larvae taken in late November, 1951. The male pupated 30th December, emerged 28th January. The female pupated 20th January, emerged 13th February. The larvae were discovered feeding at night on native tussock grasses (*Poa caespitosa* Forster and *Poa caespitosa* var. *tenera* Bentham) at an elevation of 1,000 ft. Several larvae occurred also at a site at 2,000 ft. elevation in close proximity to larvae of *H. solandri angela* and from these one was reared.

Where present the larvae were not uncommon, it being estimated that like the *H. solandri* larvae referred to in later paragraphs a larva was to be found for each thirty tussocks or so of the foodplants examined. However, the habitat is a very restricted one, the larvae occurring only where the grass is sheltered from direct sun. Even a few yards away, where conditions of less adequate shelter prevail, larvae could not be found. Two larvae may be present on the one grass tuft, unlike *H. penelope,* which seems always to be solitary in its habits.

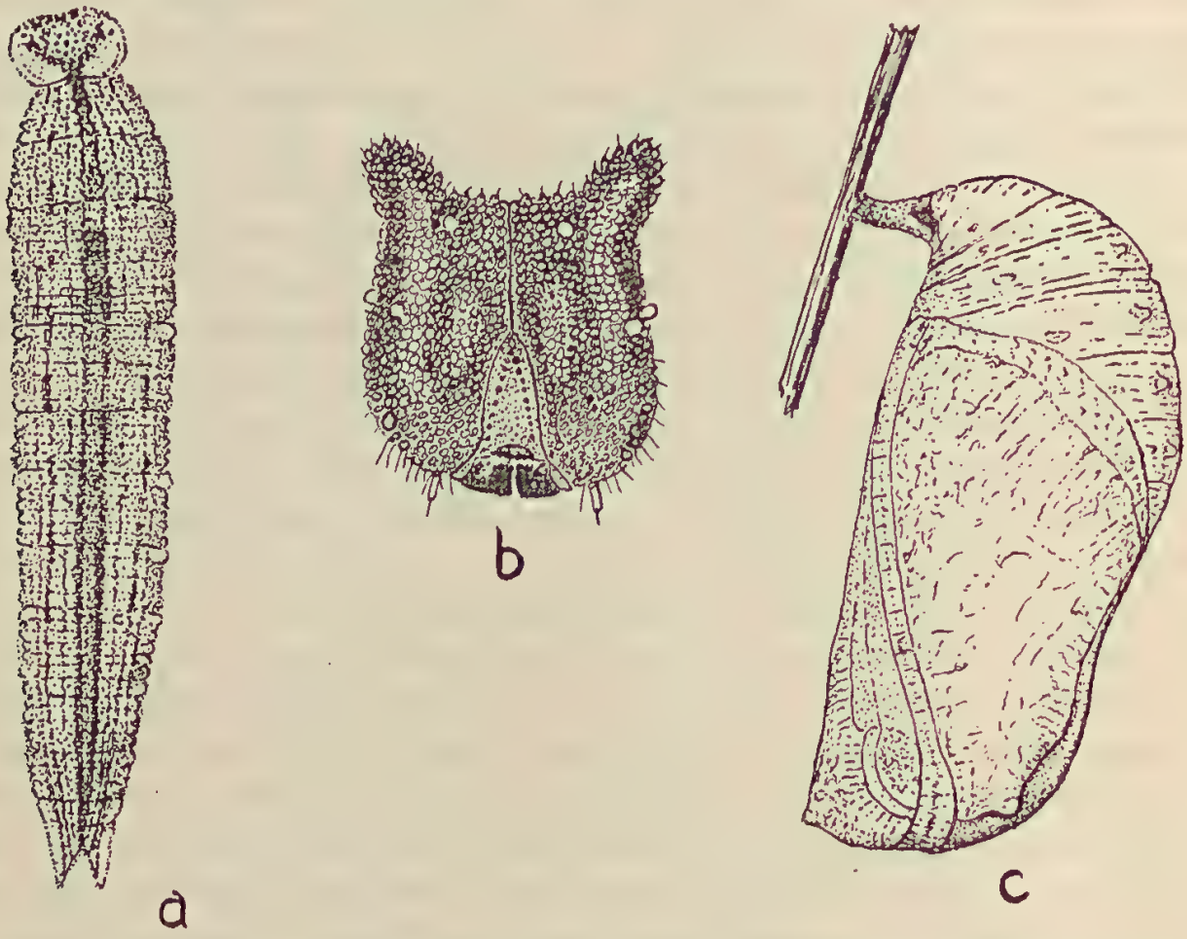

Fig. 1. a-c, *Heteronympha banksii nevina.* Mt. Rosea, 2,000 ft.; a, adult larva, length 25 mm.; b, face, diameter 2·8 mm.; c, pupa, length 12 mm.

Larva. The adult larva (text fig. 1a-b) is 23-25 mm. in length, shagreened, pale buff in colour, with longitudinal striae, the head dark brown with cream stripes. The sides of the abdomen are brown and a dark spot is present on each of the prolegs, the tip of the abdomen is bifurcate. The head, viewed from in front, bears large laterally placed, somewhat rounded projections covered with relatively large pustule-like elevations which extend over much of the face; some are dark brown and others pale cream, forming two stripes on each side of face, also a lateral stripe. There are three pustular elevations on each side, larger than the rest, and pale cream in colour.

Larvae feed after about 9 p.m. When mature they remain dormant for up to nine days resting on a pad of silk; they then suspend themselves, maintaining a flexed position, head down, for from 10 to 28 hours before the pupal ecdysis takes place.

Pupa: Bright grass green or dull purplish-brown suspended by cremaster (text fig. 1c). Length 12 mm., diameter 6 mm. There are four, sometimes five pairs of rounded processes on the abdomen. The pupation period ranged from 20-32 days. On occasion the butterfly emerges from the pupa during the hour of midnight and is then fully developed long before dawn.

HETERONYMPHA BANKSII MARIPOSA subsp. nov.

Plate xviii, fig. e-f, and plate xix, fig. f.

Male. Wings above black with orange markings, a broad pale brown suffusion over basal part of each wing extending to tornus of hindwing; orange markings of forewings as in *H. b. banksii*; basal orange patches of hindwing large but well separated from distal ones; ocellus large with large black inner ring, but outer brown ring less conspicuous than in the above mentioned form. Hindwing below with chocolate-brown markings extending over whole of wing, an opalescent purple sheen very conspicuous over the wing, eyespots both large. Wing length 27 mm., expanse 58 mm.

Female. Wings above black with orange markings and brown basal suffusion similar to the male; sex scales absent from hind margin of cell of forewing and the posterior subapical spot white instead of orange. The eye spot on hindwing above, and both of those present below are large. The chocolate-brown markings extend to base of hindwing but the opalescent sheen appears far paler there. Wing length 26 mm., expanse 56 mm.

Loc. Queensland: McPherson Range (Holotype, a male and allotype female numbered I. 19091 in South Australian Museum) taken March, 1891, by H. Tryon.

H. b. mariposa differs from *H. b. banksii* in the larger eye spots on the wings; the inner black ring is over half as big again as in the corresponding ring on the two more southern forms. Other differences lie in the larger size and greater diffusion of the orange markings.

The examples of this race described were taken by the late H. Tryon and given to R. Illidge, who in 1898 took note of them in a published list of the butterflies of the Brisbane district. They came to the South Australian Museum along with the T. P. Lucas collection. The late Dr. G. A. Waterhouse, to whom they were shown in 1931, mentioned the locality of their taking in his book (1932, p. 97). He had intended to collect specimens of his own and describe

it as the northern race. The finding of the Grampians form affords a convenient opportunity to place it on record.

Possible limiting factors in the distribution of the three races of *H. banksii,* as now recognized, are their seeming requirements of cool, grassed slopes in sheltered humid areas away from the heat of noon-day where the foodplants either are perennially green or at least remain green until January. Our efforts at breeding them show that the larvae as readily succumb to the effects of excessive moisture, as they are intolerant of dry conditions. It is probable that conditions suitable for the species occur at few if any places between the Grampians and Eastern Victoria.

The three races are separable by the following key:

KEY TO RACES OF *HETERONYMPHA BANKSII* (Leach).

1. Median black band of hindwing above narrow .... *nevina*
   Median black band of hindwing above wide 2
2. Tornal ocellus of hindwing above and below relatively small ..... *banksii*
   Tornal ocellus of hindwing above and below relatively large ..... *mariposa*

HETERONYMPHA SOLANDRI SOLANDRI Waterhouse 1904.

Plate xix, fig. a-b.

Heteronympha solandri Waterhouse 1904, p. 466.

The type male was from Poowong, January, 1893, and the female from Mt. Erica, 4,500 ft., in February, 1903. Both localities are in Eastern Victoria. The race also has been taken on Mt. Hotham, on Mt. St. Bernard at 5,000 ft., on Mt. Donna Buang at 4,000 ft., and I have it also from Tanybryn in the Otway Ranges, taken on 1st February, 1953. New South Wales records are from Mt. Kosciusko and near Jenolan Caves. It flies from late December to March.

In the Grampians its place is taken by a separate race, smaller in size and differently marked. In this western form males have the orange marks generally reduced in size but more interconnected, while the females have the orange areas much extended and in consequence appear far brighter in colour.

HETERONYMPHA SOLANDRI ANGELA subsp. nov.

Plate xviii, fig. h; plate xix, fig. c-d, and text fig. 2.

Male. Wings above black with orange markings, generally as in *H. s. solandri* but reduced in size, some sex scales along posterior margin of cell less conspicuous than in *H. s. solandri*; the sub-marginal orange spots of hindwing

obsolete; a discal series of spots parallel to termen of hindwing forming a continuous band, however, the third spot in the series is only half the width of the others; the background colour appears as a black band dividing these discal spots from the orange basal area; this band is particularly narrow where adjacent to the first and second discal spots; there is an ocellus near anal angle. Wings beneath much as in *H. s. solandri*; hindwings yellow with conspicuous opalescent purple-brown suffusion beyond end of cell. Wing length 23 mm., expanse 50 mm.

Female. Markings generally as in male, but sex scales absent; orange patch near inner margin of forewing large and connected with a basal orange area and the subcostal spot at one-half; there is a conspicuous white spot below apex; the discal spots of hindwing are continuous and the basal orange patch extends almost to inner angle. Forewings below as in male; hindwings dull yellowish-brown with a general iridescent appearance accentuated in a patch beyond end of cell. Wing length 50 mm., expanse 54 mm.

Loc. Western Victoria: Mt. Rosea, 2,000 ft. (Holotype, a male and allotype female, 25th December, 1951, collected and presented by R. H. Fisher and N. B. Tindale, numbered I. 19090 in South Australian Museum; a paratype pair 2nd and 14th January, 1952, in collection of R. H. Fisher). Two males and two females examined.

In typical *H. s. solandri* the discal series or orange spots on hindwings is broken, whereas in both sexes of the western race the spots form a continuous series only divided, in the males, by faint black lines at the veins, and in the females appearing as a solid band. The Grampians race appears to be smaller than the Eastern Mountain one.

The paratype male is similar to the type but slightly smaller; a paratype female has the orange markings rather larger and even more conspicuously connected together than in the described female specimen. The given name was suggested to me by Mr. Fisher.

An example of the larva of this interesting form was first encountered on 10th November, 1950, on Mt. Rosea at 2,000 ft., it pupated 30th December but the author failed to rear it. Additional larvae, some about to pupate, were taken in the same area the following year. They were feeding, late at night, on sheltered clumps of the tussock grass, *Poa caespitosa* Forster, and occasionally also on clumps of the tenuous form of the same species, which is found in some places.

Like those of *H. b. nevina* the larvae seem intolerant both of dry sunny conditions and excessive humidity, so that their larval habitat is very restricted.

Larva. Similar to that of *H. banksii nevina* in colour and markings, but viewed from above the dark markings on the back of the head form a conspicuous

triangle and the texture of the body surface is finer (Text fig. 2a). There is generally a pink flush over the anterior part of the body and some traces of a transverse pink tone running around the middle of each body segment. The head (Text fig. 2b) bears small lateral rounded projections. The surface, in common with the face and sides, is covered with tiny elevations, generally each bearing traces of a hair. Viewed from the front the head is finely shagreened, brown with two ill-defined paler patches. The adult larva is 23-25 mm. in

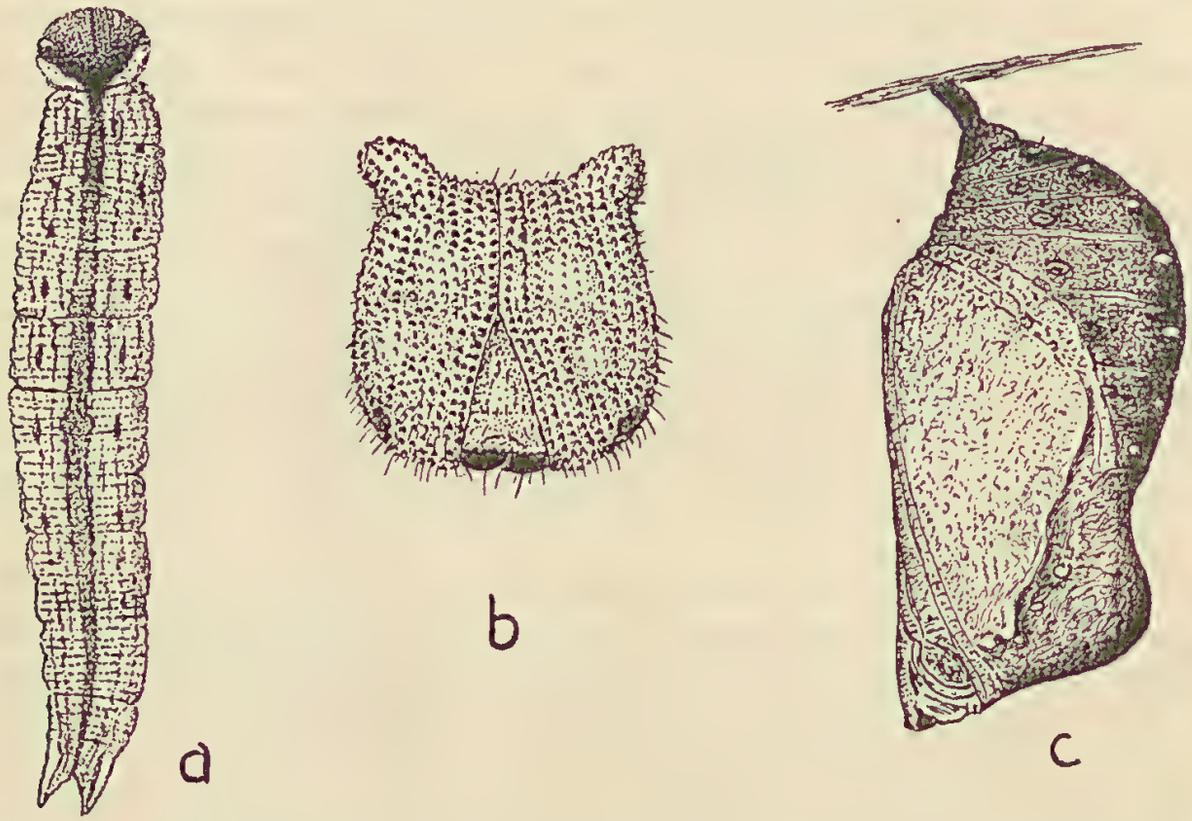

Fig. 2. a-c, *Heteronympha solandri angela.* Mt. Rosea, 2,000 ft.; a, adult larva, length 21 mm.; b, face, diameter 2·8 mm.; c, pupa of female, length 14 mm.

length. It may be distinguished from that of *H. b. nevina* by the less defined lateral projections on head, the finer shagreening, and the absence of the specialized pustular elevations present on the head in that species.

Pupa. Green, grayish-green, or as in the example figured, dark brown, almost black, with paler brown wing cases and head; there are seven rounded tubercles on each side of abdomen, each with the summit cream in colour. Length 14 mm., diameter 6 mm. The pupa drawn (Text fig. 2c), when its specific identification was checked by a partial dissection, proved to be a female. The pupal period is about 21 days.

HETERONYMPHA PENELOPE MARAIA Tindale 1952.

Further series confirm the appearance of this Grampians form as reported in an earlier paper (Tindale, 1952). In one female specimen a black bar breaks the normally linked orange patches across the forewing above but in all other characters it is like others of this race. Mr. J. Womersley has since taken a small form at Snuggery in March, 1952, thus extending the range of the species into the South-East of South Australia.

Further observations were made in the 1951-52 season on the life history of the species in the Grampians. The larvae are to be found feeding at night chiefly on large tussocks of the grass *Poa caespitosa* Forster. They were found at several places between Hall Gap and Mt. Rosea, at altitudes of from 750 to 1,000 feet. They occurred also, less commonly, on *Danthonia pilosa* R. Brown and one larva was taken on *Themeda australis* R. Brown. Nowhere common, rough counts were made indicating the finding of only one larva to each 100 tussocks of grass searched. The larvae are solitary, in no instance were two taken even on adjacent clumps. There is a prepupal resting stage of more than a week in which the larva stays among damp grass and leaves; no attempt is made by the larva to attach itself to any support and the pupa lies loose among debris held together with a few strands of silk on the ground. All the pupae seen were pale brown; a few had dark spots on the wing cases and leg sheaths. The adult emerges with a sudden and very complete rupturing of its pupal skin and is most vigorous and active while seeking a place where it may rest and expand its wings. On more than one occasion such emergences have taken place at night; one at 9 p.m. and another between midnight and dawn. Pupation periods in four different examples were 37, 41, 47 and 60 days.

HETERONYMPHA CORDACE WILSONI Burns 1947.

A large newly emerged male taken at Dartmoor, Western Victoria, 18th November, 1950, is the earliest seasonal record for the species.

A series of five freshly emerged males were taken in a swamp thicket overgrown with scented Honey-Myrtle (*Melaleuca squarrosa* Donn) on Button Grass (*Mesomelaena sphaerocephalus* R. Brown) flats of the Wannon River headwaters at 1,400 ft., on 26th and 27th December, 1952. They were alighting on and flying about sedges (*Carex fascicularis*) overgrown with a rare species of grass (*Tetrarrhena acuminata* R. Brown) not previously recorded from Western Victoria.

These are the first examples of the butterfly from the Grampians. They seem generally to be a little larger than ones taken at the type locality near

Dartmoor, on the Lower Glenelg River, otherwise they are not to be distinguished. It is possible that *Tetrarrhena* is the foodplant of *H. cordace*, since a Satyrid larva was taken on a *Tetrarrhena* grass similar to it, at Dartmoor, in November, 1950, but was not reared.

PSEUDALMENUS CHLORINDA (Blanchard) 1848.

Thecla chlorinda Blanchard 1848, pl. 3, fig. 15-18, and 1853, p. 401.

Four races previously have been described.

Pseudalmenus chlorinda barringtonensis Waterhouse 1928. Originally known only from a single male found dead on snow in October near Edwards Hut, on Barrington Tops, New South Wales; others were obtained by Messrs. Frank Dodd and A. Burns at Tubrabucca, New South Wales, in September, 1947.

Pseudalmenus c. chloris Waterhouse and Lyell 1914. New South Wales. Only known so far from Katoomba in October and Mittagong in November.

Pseudalmenus c. zephyrus Waterhouse and Lyell 1914. Eastern Victoria, Gippsland and Dandenong Ranges. Single-brooded, appearing in September, October and early November (Plate xx, fig. e-f).

Pseudalmenus c. chlorinda (Blanchard 1848). Tasmania, found usually at low elevations; very local. Single-brooded, appearing from August to November (Plate xx, fig. d). There are important notes about this race in a paper by Couchman (1948).

To these may be added a fifth race from the Grampians.

PSEUDALMENUS CHLORINDA FISHERI subsp. nov.

Plate xx, fig. a-c and text fig. 3.

Male. Forewings above brownish-black with a black spot at end of cell enclosed on three sides by a pale orange oval patch, broken into five contiguous spots by fine black lines following the veins, termen finely fringed white. Hindwings brownish-black with a small orange mark near cell outwardly from a rather darker black spot, an orange band running parallel to termen, tapering evenly towards and disappearing before apex, this partly encloses two small black spots; fringes conspicuously white, dorsum broadly suffused with white scales. Forewings beneath pale stone grey with a relatively large black discoidal spot and a more distal band; the termen narrowly margined with black. Hindwings also pale stone grey with wide orange terminal band and a series of

rather large black spots, the apical three marginal, the more posterior ones enclosed within the orange band; a black spot at tornus separated from another by the tornal portion of the orange band; a band composed of three black spots across cell. Wing length 14.5 mm.; expanse 31 mm.

Female. Forewing with orange area similar to male, with black spot of cell almost surrounded by orange. Hindwings with pale orange cell spot very large; submarginal deep orange band wide and with margins intensely black; the two black spots within it well indicated. Forewings beneath as in male; rather dull grey in colour with traces of lighter scales in position corresponding to markings above; hindwings dull grey with black markings not very evident, and reddish ones, rather diffused, extending well in from the black ones. Wing length 14.5 mm., expanse 32 mm.

Loc. Western Victoria: Mt. Victory, Grampians, 1,200 ft. (Holotype, a male, January, 1952, and allotype female, 13th September, 1952, numbered I. 19092, and a paratype male, in the South Australian Museum, collected by R. H. Fisher and the writer; a paratype pair are in the collection of R. H. Fisher). Three males, two females have been examined.

As indicated in the accompanying key, the present race differs from the others in extent of orange markings on wings above and in the distribution and relative sizes of the markings on the wings below.

From *P. c. zephyrus* it differs below in the greater development of black spots within the orange marginal band of hindwing; from *P. c. chlorinda* it differs in the absence of a second black band in the cell of hindwing.

The paratype male in the series placed in the S.A. Museum has the normally pale orange marks of the wings above almost white; in other respects it is like the other two examples.

Mr. J. C. LeSouef took one example on Mt. Rosea at 2,300 ft. in November, 1941. He realized it was a distinctive form but the specimen was lost and no further specimens have been taken at the place where he found it. On 30th November, 1951, numerous larvae were found feeding on blackwood (*Acacia melanoxylon*) shrubs near Mt. Victory. They were attended by small sweet-smelling black ants.

When disturbed the ants shepherded larvae together in clusters of up to a dozen and more, usually near a fork, and stood over them.

Eggs and larvae in all stages were present. The larvae fed readily on blackwood tips and were reared to maturity. Ants continued to minister to them until they pupated, in December. Further adult larvae and pupae were taken at the same place on 28th December, 1951. The pupae were generally

to be found hidden in crevices in bark and seemed not to be of interest to the ants.

Three male examples emerged in early January from pupae of this brood. The pupal period was about 22 days. The January emergences suggest that under some conditions there may be either a complete or a partial second or summer brood of this race. The greater proportion of the brood remained in the pupal state over the winter. Females emerged on the 13th and 14th September.

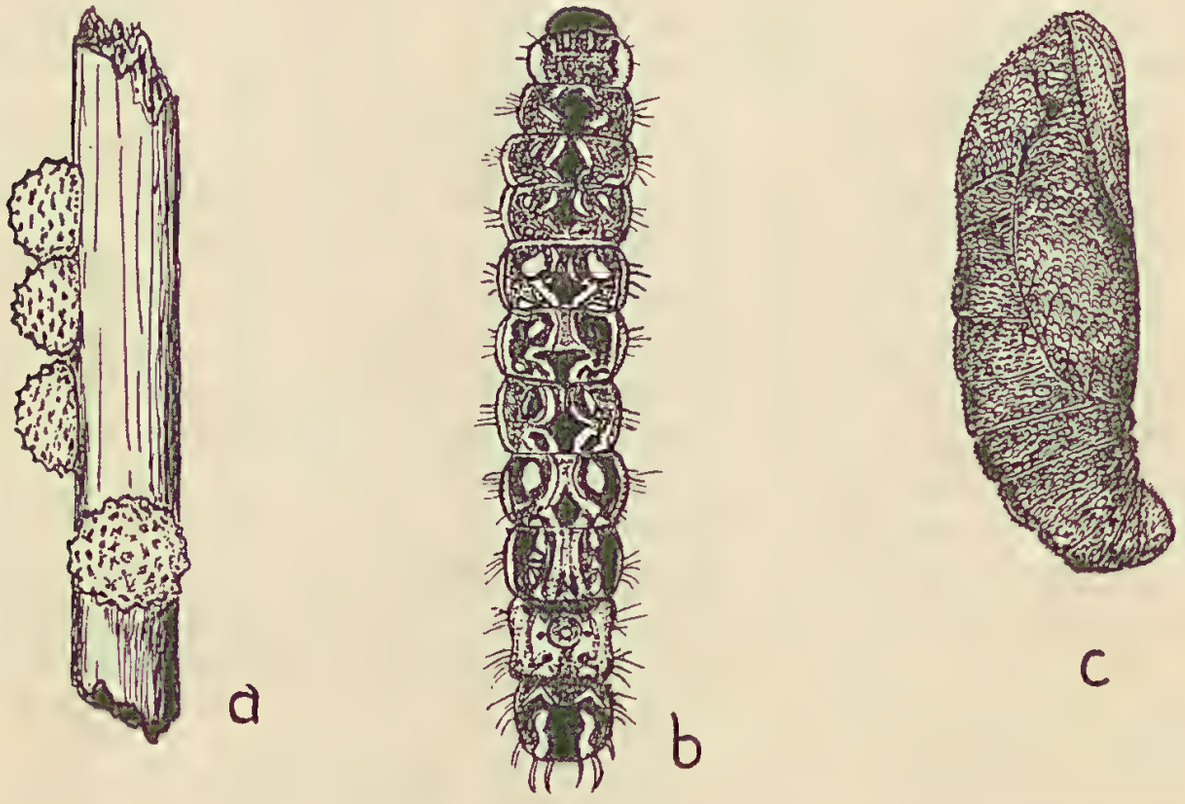

Fig. 3. a-c, *Pseudalmenus chlorinda fisheri*. Mt. Victory, 1,200 ft.; a, eggs, diameter 0·8 mm.; b, adult larva, length 19 mm.; c, pupa, length 10 mm.

The eggs are laid, up to four at a time, on tender tips of saplings and small trees. They are 0·8 mm. in diameter, greenish-white, hemispherical and pitted with coarse punctures set in spirals about the egg (Text fig. 3a).

Larvae which emerge from these eggs are 3·5 mm. in length. They complete their larval life in 28 to 33 days. There seem to be five larva instars. The adult larva (Text fig. 3b) is 18-21 mm. in length, rather cylindrical with similar diameter from prothorax to last segment of abdomen. The head is black, carried partly concealed beneath the prothorax, the body above is marked with numerous greenish-grey bands and lines together with spots of greenish-cream;

paired cream spots of larger size are present on second and fifth abdominal segments, the seventh abdominal segment has a pink suffusion. In lateral view a pink band extends from posterior margin of prothorax to the sixth abdominal segment, ventral to this band is a grey one, below it there is a narrow lighter band having white lateral hairs; the under parts are pale green.

Pupa. Brownish-black, rounded, compact, covered with fine ridges and eminences which give it a matt appearance (Text fig. 3c). It is supported by a median girdle and by a cremaster. Length 10 mm., width 4 mm.

The adult larva appears to differ from that of *P. c. barringtonensis* in the disposition of the markings, the large creamy-yellow spots usually being absent, except for ones on the second and fifth abdominal segments.

The five races of *P. chlorinda* may readily be distinguished as follows:

KEY TO RACES OF *PSEUDALMENUS CHLORINDA* (Blanchard).

1. Cell of hindwing above with orange spot 2
   Cell of hindwing above without orange spot 5
2. Cell spot of hindwing not joined to terminal orange band 3
   Cell spot joined to terminal orange band .... *barringtonensis*
3. Central orange spot of forewing large and surrounding a black internal spot .... *chloris*
   Central orange spot of forewing smaller, not surrounding the black internal spot 4
4. Orange cell spot of hindwing above relatively large .... *zephyrus*
   Orange cell spot of hindwing above relatively small (or obsolete) ..... *fisheri*
5. Hindwing below with only one series of cell spots .... *fisheri*
   Hindwing below with two series of cell spots (sometimes without orange) .... *chlorinda*

HESPERILLA CRYPSARGYRA (Meyrick) 1888.

Telesto crypsargyra Meyrick (1887) 1888, p. 829.

Hesperilla c. crypsargyra Waterhouse 1927, p. 281.

Two races of *H. crypsargyra* previously were known.

Hesperilla c. hopsoni Waterhouse 1927, is from New South Wales at Barrington Tops and Deervale, near Dorrigo, flying in January and February. The sexes are figured here (Plate xxi, fig. i-l) for comparison with a new form.

Hesperilla c. crypsargyra (Meyrick) 1888. New South Wales, from the Blue Mountains, near Blackheath and Katoomba, above 2,000 ft., where locally it is common from about 21st November until early February (Plate xxi, fig. e-h).

The following new form has been taken in the Grampians.

HESPERILLA CRYPSARGYRA LESOUEFI subsp. nov.

Plate xxi, fig. a-d, m-n, and text fig. 4a-4b.

Male. Forewings brownish-black with traces of lighter greenish-toned hairy scales on basal fourth; three sets of spots silvery-white; an oblique black sex mark from beyond end of cell to dorsum; hindwing brownish-black with an orange yellow band. Forewings beneath dull black tending to brown towards apex, with markings similar to those of upper side, but larger and pale yellow in colour; also a pale lemon-yellow series of four spots near apex; hindwing rich brown with three large silvery-white spots arranged across wing and another series of smaller ones parallel to margin; fringes alternately black and very pale yellow. Wing length 12 mm., expanse 27 mm.

Female. Similar to male but with more rounded wings and heavier body. The silvery-white markings of forewings are larger and there is an additional spot present near the posterior margin; the sex band is absent; hindwings with markings similar to those of male; the median orange yellow band broad; fringes conspicuously pale yellow and black, the yellow tone being generally darker than in male. Wings beneath as in male. Wing length 14 mm., expanse 31 mm.

Loc. Western Victoria: Mt. William 2,000-3,000 ft., locally common. (Holotype a male, numbered I. 19093 in South Australian Museum, 5th December, 1950, collected and presented by N. B. Tindale. Allotype female, 29th November, 1950, collected by J. C. LeSouef and deposited in the South Australian Museum. Paratypes are in the collections of J. C. LeSouef, F. Erasmus Wilson, R. H. Fisher and the South Australian Museum. The figured specimens are a paratype pair from the collection of F. E. Wilson; they were taken by B. B. Given). Thirty males and thirteen females have been examined.

In one aberrant male the white spots normally present beside the sex mark are lacking and in three others there is only one instead of two. Rarely, in the male, there are traces of one or two spots near the posterior margin in the position of the conspicuous spots present in the female.

H. c. lesouefi differs from typical *H. c. crypsargyra* in colour, markings, and size. The wing colour above is darker and the forewing markings are silvery-white, not pale yellow. The hindwing band is a clear orange-yellow, somewhat wider, and less interrupted at the veins than in most specimens of the typical form. Allowing for the freshness of the specimens the forewings beneath are of a far darker background colour and the silvery-white spots of the hindwing are relatively large. The small male wing expanse, ranging from 26-29 mm.

contrasts with the 32 mm. usual in Blackheath and Katoomba males of the originally named form; females also are smaller than in the two eastern races.

H. c. hopsoni is even more distinct from this new race by reason of its larger size, the deep orange-coloured marks of the forewings beneath, and the brighter brown colour of the hindwings. Examples of this new race were first taken on 13th November, 1950, in the pupal state, also as larvae, on clumps of a swordgrass (*Gahnia microstachya* Bentham). This swordgrass was growing on steep, south-facing rock walls and slopes of the Mt. William massif up to altitudes of about 3,000 ft.

At somewhat lower elevations down to 2,000 ft. larvae of the probable second and third instars were found. Between 25 and 30 clumps have to be examined for each larva found. The foodplant on Mt. William extends downwards commonly to about 1,800 ft., below which it is found only as an uncommon plant to its limit at 1,500 ft., occurring there on damp sandy slopes of Cathedral Rock among *Acacia* thickets and tea tree scrub. So far as is known the foodplant does not occur elsewhere in the Grampians and its presence seemingly has escaped scientific notice till now.

The first adult specimen of the butterfly, a male expanding 27 mm., emerged on 25th November; another of similar size and markings on 5th December, 1950. J. LeSouef reared two males and a female in the last week of November, and B. Given took specimens on the wing, and as pupae, between 13th and 19th December. Other examples were reared and taken on the wing in December, 1951. The latest emergence date is 2nd January; males seem far more abundant than females.

Life history. Egg not examined.

Young larvae, perhaps of the second or third instar, are 10 mm. in length, pale green, with traces of longitudinal markings; the head, 1·8-1·9 mm. in diameter, is pale brown with a faint median longitudinal darker brown stripe.

Larvae of a later instar (Text fig. 4a and Plate xxi, fig. m), length 14 mm., are pale olive-green, with faint traces of longitudinal brown markings, a narrow darker midline and paler brown lateral stripe. The head is 2·1-2·4 mm. in diameter, yellow with a broad black median facial band, widened anteriorly, where it is divided; viewed from above the margins of the head appear as if rimmed narrowly with brown but in the larval head-casts this is not as evident.

Adult larval shelters usually are made by drawing three leaves together in an upright position; pupation is in the open tube so formed; the third leaf often has a loop in it which seems to serve as a spring and keeps the shelter in position; there usually is a white meal over the anterior end of the pupa. The pupa (Text fig. 4b and Plate xxi, fig. n) is 18 mm. in length, smooth pale green,

with still paler wing cases, which become yellow and then brownish-black as the pupa matures, a prominent pair of horns is present on the head. The pupation period is about 21 days. Breeding sites preferred are on *Gahnia microstachya* in open patches among the Grampian Mountain gums, but some larvae and pupae were found on tussocks in dense under-brush.

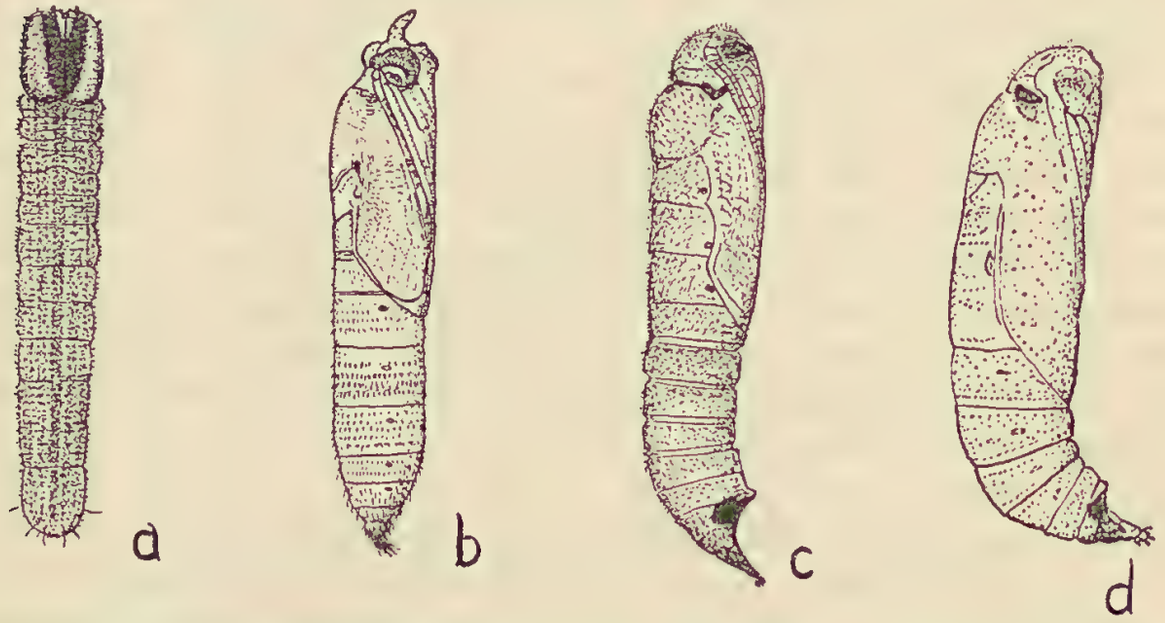

Fig. 4. 4a-b, *Hesperilla crypsargyra lesouefi.* Mt. William; a, subadult larva, length 14 mm.; b, pupa, length 18 mm. 4c, *Signeta flammeata,* Mt. Rosea; pupa, length 15 mm. 4d, *Dispar compacta,* Mt. Rosea, 1,000 ft.; male pupa, length 12 mm.

The finding of such a distinctive member of the *H. crypsargyra* group in Western Victoria suggests that with the further examination of the Eastern Victorian highlands a form of the species also should be found there. In the light of the subspecific differentiation shown by other Grampians butterflies, when compared with Eastern Victorian races, it seems possible that, if such a find is made, the form taken in Eastern Victoria will be closer to *H. c. crypsargyra* than to the Western race, *H. c. lesouefi.*

SIGNETA FLAMMEATA (Butler 1882)

Text fig. 4c.

On 10th November, 1950, a larva approximately 10 mm. in length was taken in a tussock of soft grass (*Poa caespitosa* Forster) at Mt. Rosea, by searching about 11 p.m. with a lamp. On 31st December the adult larva was 15 mm. in length, pale brown with a darker mid-dorsal line; the head brownish-black, large and with prominent eyes. The larva gathered dry grass together to form a loose shelter within which it pupated on 2nd January; the pupa was attached to the grass by a few strands of silk about the tip of abdomen. The pupa

(Text fig. 4c) is 15 mm. in length, rather cylindrical, with the head somewhat squarely truncate, brown in colour with the eyes mottled with dark brown; the last segments of the abdomen seem to possess an enlarged circular gland or specially pigmented area. On 17th January the pupa darkened. It emerged 19th January, 1951, and the butterfly was fully developed by 8 a.m. Mr. R. H. Fisher took a male specimen on the wing at Hall Gap, 29th January, 1951. In November, 1951, further larvae were taken by R. Fisher; these also emerged in January. All proved to be males.

So far as can be ascertained these are the first records of the species in Western Victoria.

It is known to occur at Killarney in Southern Queensland, at Barrington Tops, Dorrigo, Sydney, Illawarra, the Blue Mountains, and Colo Vale, in New South Wales, and in Victoria at Mt. St. Bernard, Wandin, Healesville, Gisborne, Kallista and Lorne. On 1st February, 1953, I took it at Tanybryn in the Southern Otway Range. It ranges from near sea level to about 4,000 ft.

Variations which might be considered of subspecific value have not been recognized although some examples are very dark in colour. Further study may show that the separation is warranted of the northern examples from Dorrigo and Killarney. Butler's type came from the vicinity of Melbourne.

Eastern Victorian specimens from Kallista are large, and while somewhat darker than specimens from Northern New South Wales, are not quite as dark as examples from Mt. Rosea. Mt. St. Bernard examples agree with those from Kallista except that they are a little lighter in colour. A typical freshly emerged male from Kallista expands 36 mm., and has the hindwing beneath dark ochreous, while the ochreous suffusion above is conspicuous.

DISPAR COMPACTA Butler 1882.

Text fig. 4d.

Mr. B. Given took a male of this species at Dartmoor on 31st January, 1951. It seems not previously to have been known from Western Victoria.

Larvae were taken at Mt. Rosea (1,000 ft.) in November, 1951, feeding on the grass *Poa caespitosa* Forster and also on *P. caespitosa* var. *tenera* Bentham. They can be found near midnight on the fine flower stems. These may bend over with the weight of the larva.

The larva is of the palest green with a dark head. On 3rd December three examples measured 14, 16 and 16 mm. in length when fully extended, but only 9, 10 and 11 in a contracted position such as they assume when disturbed. The largest larva pupated just prior to 26th December in a tube shelter formed by joining the two edges of a leaf with a series of equally spaced silken straps;

it emerged on 20th January, 1952. Two other larvae continued to feed until 7th January. They formed shelters by joining the edges of spills of paper in a similar manner to the leaf used by the earlier one, and pupated between 8th and 12th January. The two last named showed little signs of development on 27th January; they darkened shortly after this date and one emerged on 7th February.

Pupa pale fawn, smooth, covered with an opalescent white meal. The head is rounded, with a large black process at base of forewing. There is another large dark chestnut coloured lateral impression near the apex of abdomen; the abdominal extremity in ventral view is expanded, fan-like strongly chitinized and with a fringe of hairs. The pupa (Text fig. 4d) is similar to that of *Signeta flammeata*. With development the pupal wing cases darken. The pupal period ranges from 24 to 28 days.

The adults do not seem to differ from those taken in Eastern Victoria.

LIST OF SPECIES FROM GRAMPIAN MOUNTAINS, WESTERN VICTORIA AND VICINITY.

Delias aganippe (Donovan, 1805). Mt. William, 27th December; Wannon Falls.

Anaphaeis java teutonia (Febricius, 1775). Hall Gap; Mt. Rosea.

Pieris rapae (Linnaeus, 1758). Hall Gap.

Danaus menippe menippe (Huebner, 1816). Hall Gap. The studies of Talbot (1943), Corbet (1949), and Field and others (1951) indicate *menippe* to be the proper name of this North American visitor. The formerly used name *plexippus* Linnaeus applies to a Chinese species, displacing the name *genutia* Cramer. The lectotype of *D. plexippus*, nominated by Corbet (1949) is one of the Chinese examples studied by Linnaeus, still bearing his name label.

Vanessa cardui kershawi (McCoy, 1868). Mt. William. The name *Vanessa* takes precedence over *Pyrameis* by reason of Opinion 156 of the International Commission on Zoological Nomenclature.

Vanessa itea (Fabricius, 1775). Mt. Rosea.

Heteronympha banksii nevina Tindale, 1953. Mt. Rosea, 1000-2,000 ft.

Heteronympha solandri angela Tindale, 1953. Mt. Rosea, 2,000 ft.

Heteronympha merope merope Fabricius, 1775. Wannon Falls; Myrtlebank; Hall Gap.

Heteronympha penelope maraia Tindale, 1952. Myrtlebank, 800 ft.; Mt. Rosea, 1,000 ft.

Heteronympha cordace wilsoni Burns, 1947. Dartmoor, 18th November, 1951; Wannon River Headwaters, 1,400 ft., 26-27th December, 1951.

Geitoneura klugii klugii (Guerin, 1830). Hall Gap.

Tisiphone abeona antoni Tindale, 1948. Wannon River Headwaters, Moora, and Dartmoor, as larvae on *Gahnia psittacorum;* newly emerged female, Dartmoor, 19th December, 1951. Examples of *T. abeona* taken at Yaugher, Otway Ranges, 23rd December, 1951, are all *T. a. albifascia* Waterhouse, 1904.

Oreixenica kershawi kanunda Tindale, 1949. Dartmoor, 31st January, 1951. A newly emerged male of *O. kershawi* taken at Turton Pass, Otway Ranges, 23rd December, 1951, appears to belong to the form *O. k. kershawi* Miskin, 1876, as also long series from Lavers Hill and Tanybryn, also in the Otway Ranges, 31st January to 1st February, 1953.

Candalides acasta Cox, 1873. Little Desert, 1st December.

Candalides hyacinthina simplexa Tepper, 1882. Brimbaga, South Australia; a pair of the species from Yaugher, Otway Ranges, taken 23rd December are of the race *C. h. hyacinthina* Semper, 1878.

Hypochrysops ignita ignita (Leach, 1814). Kiata, 1st December.

Zizeeria labradus labradus (Godart, 1824). Myrtlebank.

Paralucia aenea lucida Crosby, 1951. Kiata.

Neolucia serpentata Herrich-Schaeffer, 1869. Little Desert and Kiata, 1st December.

Neolucia agricola agricola Westwood. Mt. William, 3,800 ft., 27th December; Pomonal, 11th and 28th November; Little Desert, 1st December, worn male.

Lampides boeticus Linnaeus. Taratap Station, South Australia; Hamilton, Victoria.

? Ogyris olane Hewitson. A larva on *Loranthus pendulus* at Tyrendarra, Victoria; it was not reared.

Ogyris idmo halmaturia Tepper, 1890. Brimbaga, South Australia, 23rd November and 2nd December, 1951.

Ogyris hewitsoni meridionalis Bethune-Baker 1905. At Bellfield; several pupae were taken under bark of *Acacia melanoxylon* near *Loranthus linophyllus;* of these one reared by R. Fisher proved to be an example of the aberration *hopensis* Burns, 1947, which is not a separate race since it occurs as an occasional variant in more than one place where *O. h. meridionalis* occurs.

The race *O. h. parsonsi* Angel 1951 described from Central Australia is a distinctive form of the same species. Some previous authors have been in error in associating the name *meridionalis* with *Ogyris amaryllis.* The last named is a separate species, with several races, found from South Queensland to South Australia, principally along the coast and inland near Canberra.

Ialmenus icilius Hewitson, 1865. Kiata, December.

Pseudalmenus chlorinda fisheri Tindale, 1953. Mt. Victory. Eggs, larvae and pupae on *Acacia melanoxylon* November and December; adults, January, September.

Trapezites eliena monocycla Lower, 1911. Myrtlebank, a reared example, 18th December, pupal duration 16 days; Snuggery, South-East of S. Australia, 30th January, 1953.

Trapezites sciron eremicola Burns, 1947. Little Desert, a worn example, 1st December, 1951.

Trapezites phigalioides Waterhouse, 1903. Pomonal, 11th November; Myrtlebank; Mt. Rosea, 2,000 ft., 15th November.

Trapezites phigalia phigalia Hewitson, 1868. Pomonal, 11th November.

Signeta flammeata Butler, 1882. Mt. Rosea.

Dispar compacta Butler, 1882. Dartmoor, 31st January; larvae at Mt. Rosea, 1,000 ft., emerged January.

Hesperilla chaostola chares Waterhouse, 1933. Jimmy Creek, a worn female taken by R. Fisher on 26th November.

Hesperilla donnysa delos Waterhouse, 1941. All examples taken in the Grampians area are of this race. Myrtlebank, 24th and 27th November; Jimmy Creek, 3rd December; Wannon Falls, 19th and 23rd November, 2nd December; Cavendish, 23rd November, 3rd December; Victoria Valley, 22nd November. All larvae and pupae seen were on *Gahnia radula.* The identification of the *Gahnia* has been confirmed by the National Herbarium, Melbourne.

Hesperilla chrysotricha leucosia Waterhouse, 1938. Dartmoor, 27th November, reared from pupae on *Gahnia trifida;* closer to this race than to the eastern Victorian *H. c. cyclospila* Lower.

Hesperilla idothea clara Waterhouse 1932. Mt. Rosea, Mt. Victory, and Mt. William; larvae on *Gahnia psittacorum,* 1,400-2,500 ft., males flying about summits in December. Both sexes also from Snuggery, S. Australia, 30th January, 1953.

Hesperilla crypsargyra lesouefi Tindale, 1953. Mt. William, 2,000-3,000 ft., on wing December, as larvae and pupae, November, on *Gahnia microstachya.*

Oreisplanus perornatus Kirby, 1893. Wannon Headwaters, 1,400 ft.; Lake Wartook; Mt. Victory, 2,000 ft. Larvae and pupae November; on wing late November.

DISCUSSION ON CLIMATE.

Progress of speciation in the Grampians area seems to have led to the formation of distinctive races in several species which require relatively high humidity in their environment. Among those previously reported were:

Tisiphone abeona antoni Tindale; *Heteronympha cordace wilsoni* Burns; *Heteronympha penelope maraia* Tindale; *Oreixenica kershawi kanunda* Tindale.

To this suite are now added two further Satyrids, a form of *Heteronympha solandri* Waterhouse and another of *H. banksii* Leach, a race of *Pseudalmenus chlorinda,* as well as *Hesperilla crypsargyra lesouefi* Tindale, member of a peculiarly southern Australian group of Temperate Zone Hesperiids.

The last named seems to require an environment such as is now restricted on Mt. William in Western Victoria to a belt extending from about 2,000 ft., up to the upper limit of the growth of its foodplant *Gahnia microstachya,* at about 3,000 ft. The rainfall of this area is stated to be in the vicinity of 46 inches per annum, distributed rather uniformly over the year. *H. c. lesouefi* seems to have maintained its isolated existence in Grampians area during a time sufficiently long to have diverged from forms existing further to the east. It shows well-marked subspecific differences.

The two other known survival areas for this species are in the Eastern highlands of New South Wales. The three known forms live in areas now separated from each other by belts of drier country respectively 350 and 250 miles in width where today conditions seemingly are not suitable for their existence.

Any drastic past degeneration of climate in Southern Australia probably would have caused *H. c. lesouefi* to have become locally extinct since in such an event there is no area where either it could have sought asylum, or have found its climatic needs.

Hence within the limits of time which must be allowed for the development of a distinctive subspecies of this kind, there probably has not been, in the Grampians area, any drastically arid climatic cycle.

On the contrary, the dispersal of the parent form of what are now the three known races of *H. crypsargyra,* confined respectively to (1) Barrington Tops,

(2) the Blue Mountains and (3) the Grampians, must have been affected in some period when there prevailed a cooler and wetter condition than now exists. What is at present the climate of areas situated at about 2,000-3,000 ft. elevation must then have prevailed far more generally either on the lowlands or the lesser highlands between these areas.

Another Hesperiid which shows the same type of distribution is *Trapezites eliena,* of which the Western Victorian race, *T. e. monocycla* Lower, described many years ago, is different from the Eastern form.

To South Australians the Lepidopterous fauna of the Grampians is thus of particular interest since it preserves elements of the relatively cool-wet-climate loving section of the South Australian fauna in so far as it is distinct from that of South-Eastern Australia. Some Grampians subspecies extend also to the Mt. Lofty Ranges, Kangaroo Island, Port Lincoln, and the southern Flinders Ranges, others extend only to the Mt. Lofty highlands, yet others range only into wet places in the South-East of South Australia and still others, being truly high humidity-requiring forms, survive only in the Grampians area itself, a few even being confined to specific valleys and peaks within the Grampians area.

It is of some interest to note that due to the limited number and situation of rainfall observation stations available in Western Victoria the presence of the Grampians massif, with its rainfall of over 40 inches, is not recognized on generalized climate maps such as that of Thornwaite, as elaborated by Gentilli (1948). It actually is a more extensive area of relatively high rainfall than the Mt. Lofty one and should seemingly fall into the classification as B B′r (humid, warm, rainy) with an aura of B B′s (humid, warm, summer dry) around it. The highest Grampians summit plateaux are subalpine in character. Wood (1949), in his Vegetation Map of Australia, gives no indication of the presence of the small areas of wet sclerophyll forest and incidentally also fails to show the outliers of rain forest and *Nothofagus* of the Otway Range, significant though these are from the point of view of plant distribution.

It seems evident from the study of the Lepidoptera that there is a significant faunal break between the Grampians and the mountain areas of Eastern Victoria. The Grampians fauna extends westward into the lower South-East of South Australia and to the Mt. Lofty Range itself, which must be regarded as a recently isolated outlier since recognizable subspecific differences seem not yet to have arisen between butterflies common to the Grampians and Mt. Lofty areas. At no very distant date in the past they probably were more closely linked than today; at that time the climate of the more humid highland areas must then have been present in the low country between them.

The Otway Range fauna is different to that of the Grampians, favouring more a relationship with the Eastern Victorian mountain areas. Hence it is probable that what is now the fauna of the wet Otway Ranges at 1,000-1,800 ft., was formerly that of a moist lowland belt continuous with that of Gippsland when it was a little cooler than now. Examples suggesting this are *Tisiphone a. albifascia,* which occurs in the Otways, not *T. a. antoni;* also *Oreixenica k. kershawi* and not the form *O. k. kanunda.* The broad belt of savannah land between the Otways and Grampians effectively divided these two areas even during the suggested cooler, more humid interval.

The button grass incidentally referred to in recording the capture of *H. cordace wilsoni* on the swamp flats at the headwaters of the Wannon River is the same species (*Mesomelaena sphaerocephalus* R. Brown) as is found in Western Tasmania on swamp lands in the old glacial valleys. Although locally rather common on the headwaters of the Wannon and occurring elsewhere in the wettest parts of the South-East of South Australia, it nowhere in the Grampians seems to cross the low divide to the headwaters of the northward flowing Fyans Creek. It is possible therefore that its distribution is intimately tied to the past climate of the Grampians region and on the headwaters of the Wannon and in the South-East of South Australia it may be a relict form making a last stand and witness to former wetter and possibly cooler conditions in the country south of the Grampians. Similar witness is perhaps borne by the postclimax communities of tree ferns and attendant *Pomaderris apetala* Labillardière thickets about Mt. Rosea.

ACKNOWLEDGMENTS.

I am indebted to Mr. S. Blake, of the Botanic Museum and Herbarium, Brisbane, for identifications of *Gahnia* sword grasses. He informs me that ours is perhaps the first report of *Gahnia microstachya* Bentham from Western Victoria. A previous Victorian record, according to Mr. J. C. LeSouef, is from the Avon Range, north of Stratford, Gippsland, where it was collected in 1854 by Baron F. von Mueller.

Prof. J. B. Cleland has kindly provided identifications of several shrubs and grasses and submitted others to Mr. A. W. Jessep, Director of the National Herbarium, Melbourne, for confirmation; I am indebted to both for their help.

Mr. Keith Hateley kindly placed his knowledge of the Kiata district and Little Desert at our disposal, enabling interesting series to be obtained within a minimum of time.

Mr. J. C. LeSouef kindly consented to lodge an allotype female specimen of *H. c. lesouefi* in the South Australian Museum and he and Mr. B. B. Given

contributed freely of their knowledge and experience to make the visits to the Grampians a success.

Mr. F. E. Wilson kindly loaned two paratype specimens of *Hesperilla c. lesouefi* which have been figured. Mr. R. Fisher, my companion on the second visit to the area, also kindly placed type material in the South Australian Museum when my own takings were not adequate for the purpose. All material listed, other than that in the collections of my companions, has been presented to the South Australian Museum.

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EXPLANATION OF PLATES.

Plate xviii.

Fig. a-b, *Heteronympha banksii nevina.*
(a) holotype male, Mt. Rosea, 1,000 ft., 28th January, 1952.
(b) allotype female, same locality, 13th February, 1952.

Fig. c-d, *Heteronympha banksii banksii.*
(c) male, Clifton, 16th March, 1898. (d) female, Roseville, 4th April, 1904.

Fig. e-f, *Heteronympha banksii mariposa.*
(e) holotype male, McPherson Range, March, 1891. (f) allotype female, same details.

Fig. g, *Heteronympha banksii nevina.*
paratype female, Mt. Rosea, 1,000 ft., 9th February, 1952, underside (specimen in Fisher collection).

Fig. h, *Heteronympha solandri angela.*
allotype female, Mt. Rosea, 2,000 ft., 25th December, 1951.

Plate xix.

Fig. a-b, *Heteronympha solandri solandri.*
(a) male, Mt. Hotham, January, 1904. (b) female, same details.

Fig. c-d, *Heteronympha solandri angela.*
(c) holotype male, Mt. Rosea, 2,000 ft., 25th December, 1951. (d) allotype female, same details.

Fig. e, *Heteronympha solandri solandri.*
male, Mt. Donna Buang, 4,000 ft., 12th February, 1949, underside.

Fig. f, *Heteronympha banksii mariposa.*
holotype male, McPherson Range, March, 1891, underside.

Fig. g, *Heteronympha banksii nevina.*
paratype male, Mt. Rosea, 22nd January, 1952, underside (specimen in Fisher Collection).

Fig. h, *Heteronympha banksii banksii.*
male, Clifton, 16th March, 1898, underside.

Plate xx.

Fig. a-c, *Pseudalmenus chlorinda fisheri.*
(a) holotype male, Mt. Victory, 1,200 ft., 6th January, 1952.
(b) paratype male, same locality, 7th January, 1952.
(c) paratype male, same locality, 10th January, 1952, underside. (Last-named specimen in Fisher Collection.)

Fig. d, *Pseudalmenus chlorinda chlorinda.*
male, Kingston, Tasmania, November.

Fig. e-f, *Pseudalmenus chlorinda zephyrus.*
(e) male, Gisborne, 30th October, 1894. (f) male, Moe, October, 1922, underside.

Plate xxi.

Fig. a-d, *Hesperilla crypsargyra lesouefi.*

(a-b) paratype male, Mt. William, 19th December, 1950, upper and under side. (c-d) paratype female, Mt. William, December, 1950, upper and under side (specimens in F. E. Wilson collection).

Fig. e-h, *Hesperilla crypsargyra crypsargyra.*

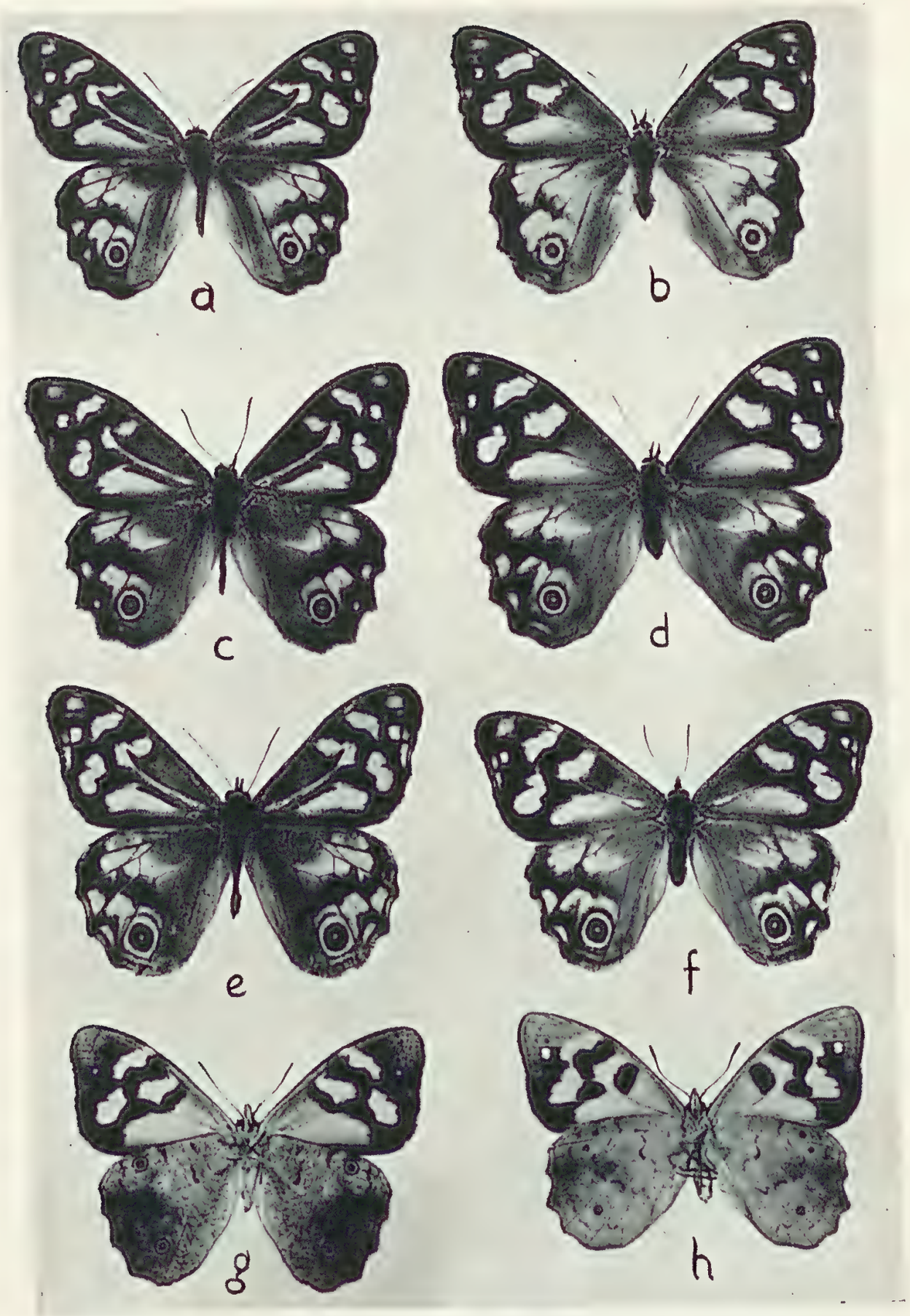
(e-f) male, Blackheath, upper and under side. (g-h) female, Katoomba, upper and under side.

Fig. i-l, *Hesperilla crypsargyra hopsoni.*

(i-j) male, Barrington Tops, upper and under side. (k-l) female, Barrington Tops, upper and under side.

Fig. m-n, *Hesperilla crypsargyra lesouefi.*

(m) subadult larva, Mt. William. (n) pupae, showing three aspects.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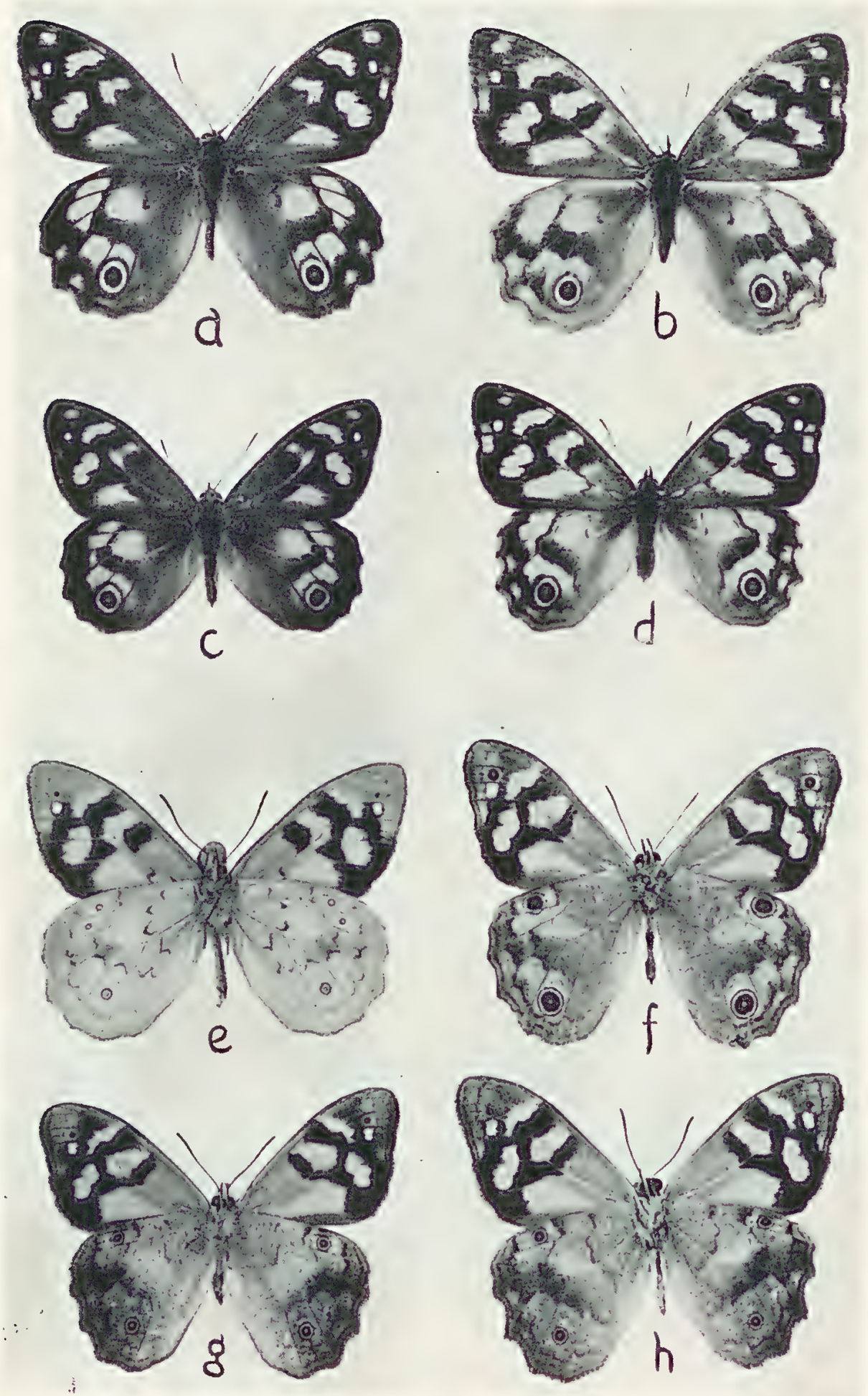
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On the SARCOPTID or MANGE-MITES of the WOMBAT

By H. WOMERSLEY, South Australian Museum.

A Sarcoptid mite infesting the skin of the Australian Wombat has been known since 1893, when Railliet (Traité Zool. med. et agric., 2nd ed.) recorded without description or figures, a mite which had been found by Dumeril on the skin of a wombat from Australia in the Museum nationale d'Histoire naturelle de Paris. Apparently on the opinion of Fournier, the mite was considered to be identical with that of man, *Sarcoptes scabei* (Linn. 1758) and was given the variety name of *wombati*. It was said to be able to affect man (the keepers in charge of the wombat while in captivity) and to cause larger vesicles than the human scabies.

Apart from the above information which has been repeated by many writers, viz., Canestrini and Kramer in "Das Tierreich, Lfg. 7, 1899"; Warburton in "Parasitology, *12*, 289, 1920"; Lemaire in "Traité d'Entomologie Med. et Vet., 1938"; and Rainbow in "Rec. Aust. Museum, *6*, 190, 1906 (who also gives the species of wombat as *Phascolomys ursinus* Shaw (= *Vombatus ursinus ursinus* Shaw in Iredale and Troughton, which if correct would indicate that the specimen was from Tasmania), no records, descriptions or figures of fresh material have been found in the literature.

In 1937, however, specimens were collected from wombats and were identified by Dr. R. N. McCulloch as *Sarcoptes scabei* (L.). A slide of this material was sent to Mr. S. L. Allman, of the Department of Agriculture, New South Wales.

Fortunately Mr. Allman has been able to find this slide, which contained seven females and three males, and I am greatly indebted to both Dr. McCulloch and Mr. Allman for the opportunity of examining this material.

The specimens have been remounted on individual slides, and I am now able to give certain details of the morphology, figure both sexes, and fully confirm the identification.

I am also indebted to Mr. David Lee for the opportunity of examining four other slides of Dr. McCulloch's material left at the School of Public Health and Tropical Hygiene, Sydney. These slides contained numerous specimens of both sexes and young stages.

FAMILY SACOPTIDAE.

Genus SARCOPTES.

SARCOPTES SCABEI v. WOMBATI Railliet 1893.

Sarcoptes scabei v. *wombati* Railliet 1893, Traité de Zool. med. et agric., 2nd ed. (nom.nud.).

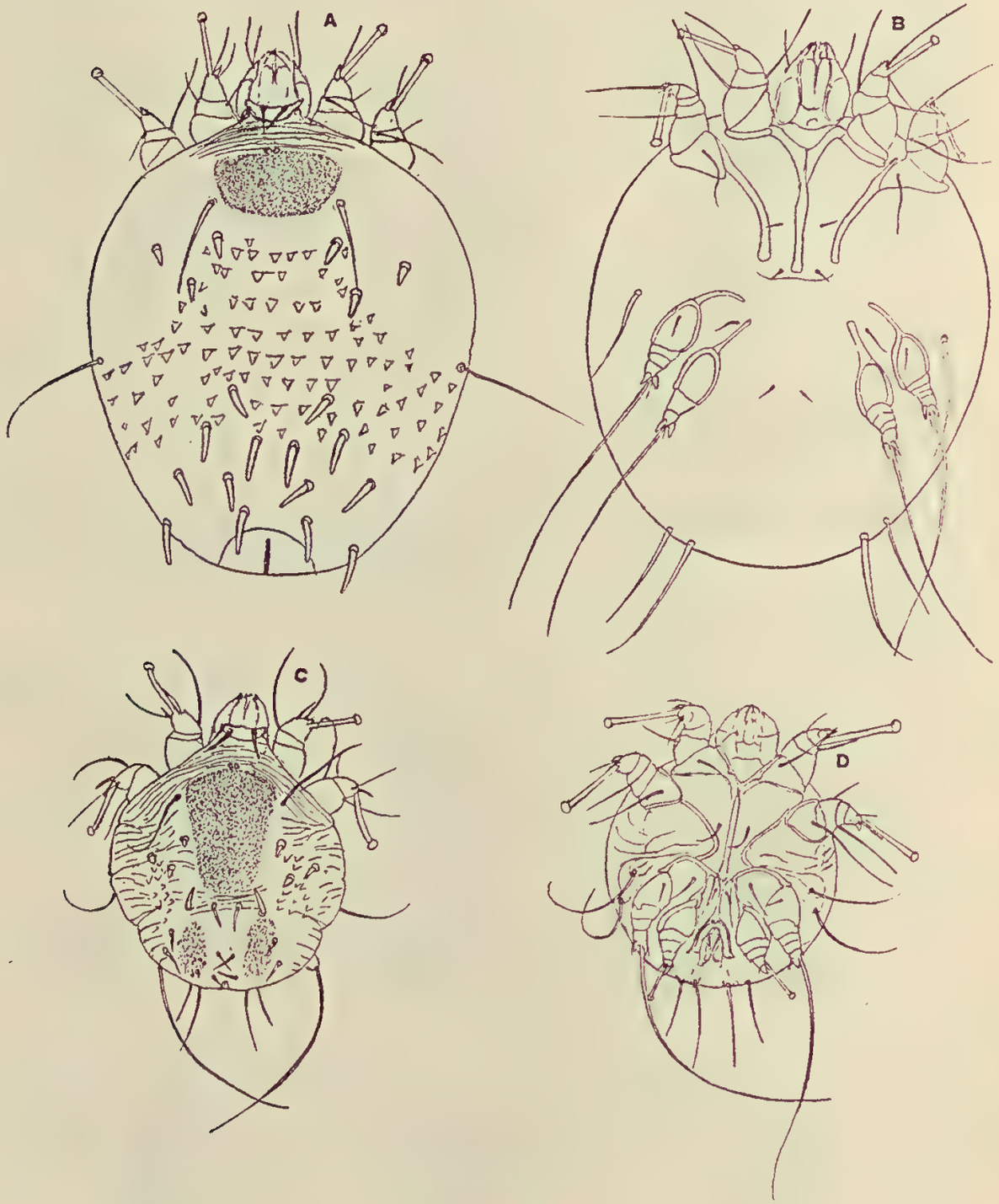

Fig. 1. *Sarcoptes scabei* v. *wombati* Railliet 1893. A-B, Female: A dorsal, B ventral; C-D, Male: C dorsal, D ventral.

Description: As in *S. scabei* and its various physiological races, from different host species. *Female.* Length of idiosoma of mounted specimens 320μ, width 299μ. Length of dorsal cones 16μ, of dorsal spines 34μ. *Male.* Length of idiosoma 162μ, width 169μ, dorsal cones 8μ, dorsal spines 17μ.

Loc. and Host. From wombats, species ?, from Goulburn, New South Wales, June, 1937 (coll. the District Veterinary Officer).

Recently I have received through Mr. T. G. Campbell, of the Division of Entomology, C.S.I.R.O., Canberra, some sarcoptid material taken from a specimen of *Vombatus hirsutus hirsutus* Perry 1810 (= *mitchelli* auct.) which was killed on the Bundabella Road, Australian Capital Territory, on the 13th July, 1951.

This new material, while being closely related to the Sarcoptidae, differs in so many respects that a new family is required for it.

FAMILY ACAROPTIDAE nov.

With a pair of vertical setae. Cuticle striated. Caruncle stalked on short legs. Without dorsal cones, spines or scales. Female with only propodosomal shield; male with both propodosomal and hysterosomal shields. Male with anal suckers.

Remarks. Closely allied to the Sarcoptidae, differing in the above characters. In the structure of the third and fourth legs and the anal suckers in the male, however, it shows some resemblance to *Megninia* of the *Analgesidae,* a family confined to birds, and in which vertical setae are wanting.

Genus ACAROPTES nov.

Female with legs I and II normal, tarsi furnished with a single claw and a shortly pedunculate sucker; legs III and IV short, without claws or suckers but ending in a pair of very long setae; epimera of leg I united apically; genitalia between legs II and III. Male with all legs of normal length except III, which is half the length of IV; I and II furnished with tarsal pedunculate sucker and paired bifurcate claws; leg III with tarsus ending in a short stout claw; leg IV ending in two long setae and two lanceolate spines; anal suckers present.

Dorsum striate, with propodosomal and hysterosomal shields in the male, propodosomal only in female; without dorsal spines; apically in the male the abdomen is divided into six short lobes, each with a long seta, the middle pair of which are slightly expanded basally.

Genotype *Acaroptes vombatus* sp. n.

ACAROPTES VOMBATUS sp. n.

Description. Female. Shape oval, but anterior of shoulder the sides are concavely converging to the rounded apex. Length of idiosoma 380μ, width 300μ. Dorsum striated with a single anterior small dorsal shield as figured; furnished with a pair of vertical setae 16μ long, three median pairs of setae of moderate length ca. 50μ, on each side of the first of these pairs is a very long seta of almost body length, and laterally of these another of moderate length;

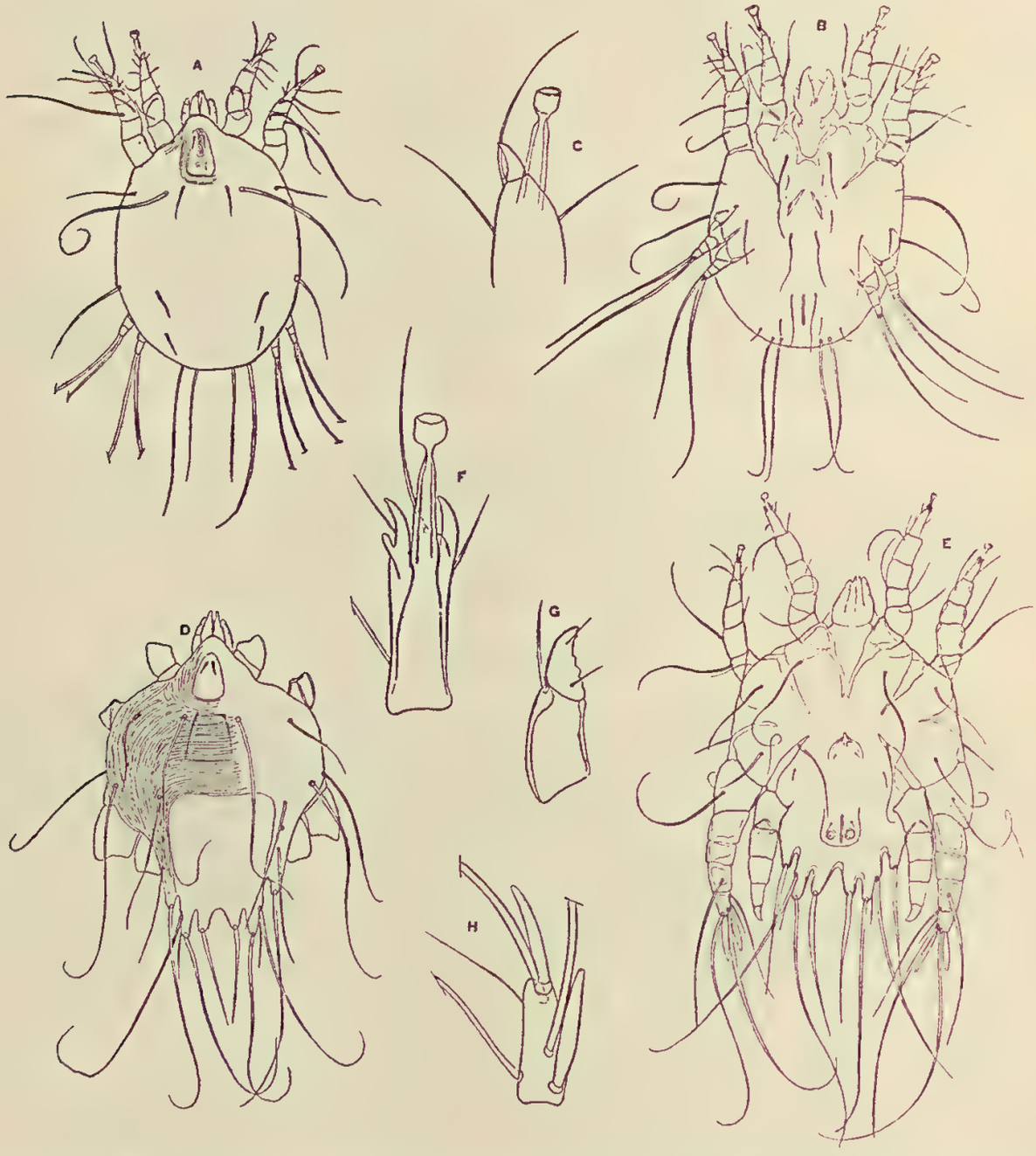

Fig. 2. *Acaroptes vombatus* g. et sp. n. A-C, Female: A dorsal, B ventral, C tip of tarsus I or II; D-H, male: D dorsal, E ventral, F tarsus I or II, G tarsus III, H tarsus IV with long setae cut off.

laterally on level of coxae III another of moderate length. Ventrally: epimera of leg I united medially; a seta on coxae I, II, III; genitalia between coxae II and III, flanked by three fine setae, the third of which is fairly long and sinuous; anus also flanked by three setae, the anterior of which is fairly long and sinuous; legs I and II of normal length, tarsi furnished with a short stout claw, and a fairly long caruncle and sucker; legs III and IV short, tarsi without claws or caruncles and sucker, but ending in a pair of very long setae.

Male. Shape as figured. Larger than female. Length 780μ, width 650μ. Dorsum with striate cuticle, and two dorsal shields, an anterior as in female and a larger posterior shield; body posteriorly with six lobes, the medial pair with a moderately long basally slightly expanded seta, the next and longest lobe with two very long and one short seta, and the short outer lobes with a long seta; other dorsal setae much as in female. Ventrally: epimera of leg I free as figured. Legs all of normal length, except III which is only half as long as IV; tarsi I and II with shorter caruncle than in female and ending in a pair of bifid claws (see figure), III ending in a single strong stout claw with a few inner small teeth; IV with tarsus ending in two very long setae and a pair of strong lanceolate setae. Anus flanked on each side by an anal sucker.

Chelicerae in both sexes small, with two blunt teeth. Palpi apparently three segmented.

Remarks: Described from 11 males and 18 females in the collection of the South Australian Museum.

A BRIEF REVISION OF THE FOUR-FINGERED MEMBERS OF THE GENUS *LEIOLOPISMA* (LACERTILIA)

By FRANCIS J. MITCHELL, South Australian Museum.

Text fig. 1-4.

Several specimens belonging to the "Heteropus" subgroup of this genus were collected in 1948 by the National Geographic Society, Smithsonian Institution and Commonwealth Government Expedition to Arnhem Land. Considerable difficulty was experienced in identifying these specimens for inclusion in the official report on the expedition, and therefore a brief revision of the group, characterized within the genus by the presence of 4 + 5 digits and an undivided fronto-parietal, has been compiled in an endeavour to clarify the taxonomy. This work has been handicapped by the inadequacy of the material and data availaible, the inconstancy of certain characters in some species, but apparent constancy in others, necessitating the examination of a large number of specimens of all recognizable forms. Until more extensive collections are made, the distribution and interrelationship of the twelve Australian lizards recognized in this work cannot be determined satisfactorily.

The following abbreviations of Museum titles have been utilized to indicate the institution in which each specimen is housed: "U.S.N.M.," United States National Museum, Washington; "M.C.Z.," Museum of Comparative Zoology, Harvard; "A.M.," Australian Museum, Sydney; "S.A.M.," South Australian Museum, Adelaide; "Q.M.," Queensland Museum, Brisbane; and "M.M.," Macleay Museum, University of Sydney.

I wish to acknowledge my appreciation of the co-operation of Mr. G. Mack, Director, Queensland Museum, Brisbane, and Messrs. J. Henry and S. J. Copland of the Macleay Museum, University of Sydney, in making the De Vis and Macleay type material, together with their opinions thereon, available for my examination. Also, I am grateful to Mr. Arthur Loveridge, of the Museum of Comparative Zoology, Harvard, for his assistance in obtaining the loan of two specimens collected at Coen, Queensland, which are herein considered to represent a previously undescribed species.

Key to the Australian Species and Races.

These species have proved difficult to key, few possessing an outstanding distinguishing feature. Also, the limited number of specimens available has

in many cases prevented determination of the stability of some features, and therefore their suitability for use in a key is in doubt.

1. Interparietal distinct 2
   Interparietal fused with frontoparietal ..... *rhomboidalis*

2. Dorsal scales smooth 3
   Dorsal scales keeled 7

3. Palpebral disk much larger than ear 5
   Palpebral disk equal to ear 4

4. Dorsal and lateral colouring uniform ..... *fuscum fuscum*
   Darker and/or lighter dorso-lateral stripes present ..... *fuscum variegatum*

5. 28 or less midbody scales ..... *novae guineae*
   30 or more midbody scales 6

6. Prefrontals separated ..... *maccooeyi*
   Prefrontals contacting or forming short median suture ..... *tetradactylum*

7. Majority of dorsal scales tricarinate 8
   Majority of dorsal scales bicarinate 12

8. Prefrontals separated on the midline 9
   Prefrontals forming a median suture ..... *triacantha*

9. Dorsal scales with simple keels 10
   Dorsal keels broken into series of points ..... *coense*

10. Palpebral disk much larger than ear ..... *pectoralis*
    Palpebral disk equal to ear 11

11. Dorsal and lateral colouring uniform ..... *fuscum fuscum*
    Darker and/or lighter dorso-lateral stripes present ..... *fuscum variegatum*

12. 28-32 midbody scales 13
    38-40 midbody scales ..... *vertebralis*

13. Palpebral disk much larger than ear ..... *vivax*
    Palpebral disk equal to ear ..... *bicarinatum*

Both *fuscum* and *pectoralis* show wide variation in the degree of keeling of the dorsal scales. Both the keeled and the smooth varieties of *fuscum* are included in the above key, but only the keeled variety of *pectoralis*. Apart from the fact that I have not seen a perfectly smooth scaled example of the latter species, the inclusion of this variety could not be made without greatly complicating the key. It has therefore been omitted, although its probable existence could be borne in mind when using this key for the identification of smooth scaled specimens.

LEIOLOPISMA FUSCUM FUSCUM (Dumeril and Bibron).

Heteropus fuscus Dumeril and Bibron, 1839, p. 759.
Heteropus schmeltzii Peters, 1867, p. 23.
Heteropus tricarinatus Meyer, 1874, p. 133.
Heteropus longipes Macleay, 1877, p. 66.
Heteropus sexdentatus Macleay, 1877, p. 67.
Heteropus maculatus De Vis, 1885, p. 169.
Heteropus rubricatus De Vis, 1885, p. 170.
Heteropus rostralis De Vis, 1885, p. 171.

Specimens examined: Northern Territory: U.S.N.M. 128612-128617, 128519, Yirrkala; A.M. R13583, 13584, 13656 (3 specimens), Cape Arnhem.

Queensland: Q.M. J7796, Iron Range, Cape York Peninsula; Q.M. J7778, South Percy Island, Northumberland Group; Q.M. J7790, Rockhampton (topotype of *H. schmeltzii* Peters); Q.M. J5639 Lindeman Island, Cumberland Group; Q.M. J7801, Archer River, Cape York Peninsula; A.M. J230 Cardwell (holotype of *H. rostralis* De Vis); S.A.M. R2969-2970, Port Douglas; M.M. R427, Endeavour River (holotype of *H. longipes* Macleay); M.M. R462-464, Cape Grenville (types of *H. sexdentatus* Macleay).

Variation: Midbody scales in 32 rows (3 specimens), 34 rows (12 specimens) or 36 rows (9 specimens). Dorsal scales obtusely trikeeled, tristriated, or perfectly smooth; occasional quinquecarinate scales on the nape. Four upper labials (five in A.M. R13584) anterior to the subocular. Ear opening vertically oval, of similar size and shape to the horizontally oval palpebral disk; auricular lobules very variable, varying from 3-5 short, acute lobules on the anterior border and 1-2 large but obtuse lobules on the posterior border to numerous acute lobules on all borders. Six or seven supraciliaries; 27-32 lamellae beneath the fourth toe.

In the Arnhem Land specimens the dorsal colouring is dark brown to olive without any sign of dorso-lateral markings in either juvenile or adult specimens, while in the Queensland material faint indication of a black dorso-lateral stripe is evident on the neck of several small specimens, and the dorsal colour has faded to grey in the long-preserved material.

Discussion: The presence or absence of dorso-lateral markings has been used as a key character for the separation of the eastern *(fuscum variegatum)* and western *(fuscum fuscum)* races in New Guinea. The Arnhem Land material agrees with the western race in possessing uniform dark brown dorsal and

lateral colouring, while those examined from islands in Torres Strait agree with the eastern race, possessing a light-edged black dorso-lateral stripe extending from the ear to above the shoulder, and part or all the way along the body. However, the task of satisfactorily stabilizing the subspecific names in this species is complicated by the Cape York Peninsula specimens, which have been described under various names by Peters, Macleay and De Vis. This material is shown to be intermediate between the New Guinea races, the juvenile colour pattern agreeing with the eastern race, while that of the adult is uniform as in the western race.

Accepting the adult colouration as standard, all Australian mainland specimens have been placed under *fuscum fuscum*, although some Cape York adults no doubt show sign of the dorso-lateral markings. Should the markings prove to be present in the greater majority of adult skinks from the vicinity of Rockhampton, *schmeltzii* Peters (1867) may be considered to hold priority over *variegatum* Macleay (1877) for the eastern race.

The type specimens of *schmeltzii, maculatus, rubricatus,* and the two smallest specimens of the *sexdentatus* types (M.M. R463-464) appear to have possessed some dorso-lateral markings.

A re-examination of Q.M. J230, the holotype of *Heteropus rostralis* De Vis indicates that the name should be placed in the synonomy of *fuscum* rather than that of *rhomboidalis,* to which it was doubtfully referred by Boulenger (1887, p. 285). De Vis (1887, p. 822) also recognized this, but retained *rostralis* on the grounds of its possessing strongly compressed toes. The dehydrated condition of the type specimen leaves doubt as to the value of this character.

LEIOLOPISMA FUSCUM VARIEGATUM (Macleay).

Heteropus variegatus Macleay, 1877, p. 66.
Heteropus quinquecarinatus Macleay, 1877, p. 67.
Heteropus cheverti Macleay, 1877, p. 67.
Heteropus luctuosus Peters and Doria, 1878, p. 364.
Lygosoma atrogulare Ogilby, 1890, p. 94.
Lygosoma nigrigulare Boulenger, 1897, p. 700, pl. vii, fig. 3.
Leiolopisma pullum Barbour, 1911, p. 15.
Leiolopisma fuscum diguliense Kopstein, 1926, p. 88.

Specimens examined: M.M. R384-385, Barrow Island, Queensland (type specimens of *H. cheverti* Macleay); M.M. R389-391, Darnley Island, Torres Strait (type specimens of *H. variegatus* Macleay); M.M. R422-426, Darnley

Island, Torres Strait (type specimens of *H. quinquecarinatus* Macleay); Q.M. J1509, Darnley Island, Torres Strait; Q.M. J6438, Yorke Island, Torres Strait; J6445, Prince of Wales Island, Torres Strait.

Variation and Discussion. This race is not readily distinguishable from the type race on structural characters, although the present material suggests that it may possess a lower average of midbody scales and subdigital lamellae. This series shows a variation of 32 midbody scales (4 specimens), 34 midbody scales (10 specimens), 36 midbody scales (1 specimen); subdigital lamellae beneath fourth toe, 24-30. Dorsal scales weakly tricarinate; a few faintly quinquecarinate scales in the *quinquecarinatus* type series.

Colouration constant; markings less prominent in the fully adult specimens. The longitudinal stripes in the dorso-lateral region provide the only sure means of identifying this race without knowledge of the locality.

Loveridge (1948, p. 309, 361) was unable to diagnose the positions of *variegatus, quinquecarinatus* and *cheverti* from Macleay's short descriptions and therefore accepted *luctuosus* Peters and Doria (1878) as holding priority for this race. However, the present examination indicates all three of Macleay's names to be synonymous with *luctuosus* and hold priority over it. *Heteropus schmeltzii* (Peters, 1867) could hold priority for this race if Rockhampton skinks are shown to consistently retain their dorso-lateral markings to adulthood. (See discussion on the type race.)

Of the *H. variegatus* type series, M.M. R390 has been chosen as lectotype and the following detail compiled from it to supplement the type description. Axilla to groin measurement 1⅓ times the forelimb to tip of snout length; when the limbs are adpressed along the body the fourth toe reaches the elbow. Midbody scales in 32 rows; dorsals and laterals weakly tricarinate. Ear opening vertically oval, its vertical diameter being equal to the horizontal diameter of the palpebral disk, which is half that of the ocular slit, three acute auricular lobules present on the anterior border. The fourth of seven upper labials largest, subocular; four supra-oculars; seven or eight supra-ciliaries. Length of the frontal equal to that of the fronto-parietal; internasal-frontal suture equal to one-quarter the internasal-rostral suture. Subdigital lamellae formula for hind limb, 16,27,18,14,8. No markedly enlarged anal scales.

Dorsal colour. fawn, with a white-edged black dorso-lateral stripe commencing behind the eye and extending from above the ear to the shoulder and along the body to the hind limb, becoming less prominent posteriorly. The light lower border of the stripe passes through the ear.

Measurements: 128 (46 + 82) mm.

All three of the type specimens possess 32 midbody scales and 26 or 27 lamellae beneath the fourth toe.

The abovementioned *H. variegatus* types and those of *H. quinquecarinatus* appear to represent the juvenile and adult respectively of the Darnley Island population of this race. In two of the five *H. quinquecarinatus* types occasional scales could be considered quinquecarinate, but by far the greater majority are obtusely tricarinate, and except for the less prominent dorso-lateral stripes and the inconstancy of the upper labials, M.M. R422 possessing five labials anterior to the subocular on both sides and M.M. R425 on one side, these specimens show no features which could be used to separate them from the subadult *H. variegatus* types. The largest specimen, M.M. R422, measures 130+ (65 + 65+) mm.

The Barrow Island lizards described as *H. cheverti* by Macleay show similar variation, M.M. R384 measuring 132 (43 + 89) mm., possessing the dorso-lateral markings, while in M.M. R385 measuring 118+ (57 + 61+) mm. the dark stripe is only visible for a limited distance on the neck.

Loveridge (1948, p. 363) has keyed two additional races of this species, *jamnanum* Loveridge from Jamna Island, Dutch New Guinea, and *beccarii* (Peters and Doria) from Kei Islands, Dutch East Indies. In addition, he suggests that *leucotaenia* (Bleeker, 1860) from Ceram will prove to be a fifth race (? = *schlegelii* (Peters, 1864) from Amboyna and Timor).

LEIOLOPISMA VERTEBRALIS (De Vis).

Fig. 1.

Heteropus vertebralis De Vis, 1888 (1887), p. 821.

Lygosoma mundivense Broom, 1897, p. 643.

Lygosoma waitei Zietz, 1920, p. 211 (nom. nov. for *vertebralis* as preoccupied in *Lygosoma*).

Specimens examined. Queensland: Q.M. J248, Chinchilla, Darling Downs (one of the type series); Q.M. J4408, Townsville; S.A.M. R2967-2968, Irvinebank; S.A.M. R2958, R2966, Kaban.

From a comparison of its type description with the present material, *Lygosoma mundivense* Broom would appear to be synonymous with *vertebralis*.

Q.M. J248, one of the type series forwarded for examination from the Queensland Museum, has been designated the lectotype, and the following data and fig. 1 compiled from it. Midbody scales in 40 rows; four lower labials

anterior to the subocular; four supraoculars and seven supra-ciliaries. Dorsal and lateral scales mostly bicarinate, but with occasional tri- and quadricarinate scales, particularly towards the nape. Subdigital lamellae constant, 23 or 24 beneath fourth toe of the lectotype and 22-24 for the remainder of the material examined. Ear opening a little shorter than the transparent palpebral disk, almost round, with short acute lobules on all borders, the one or two on the anterior border being most prominent. The snout of this species is strongly depressed (see fig. 1).

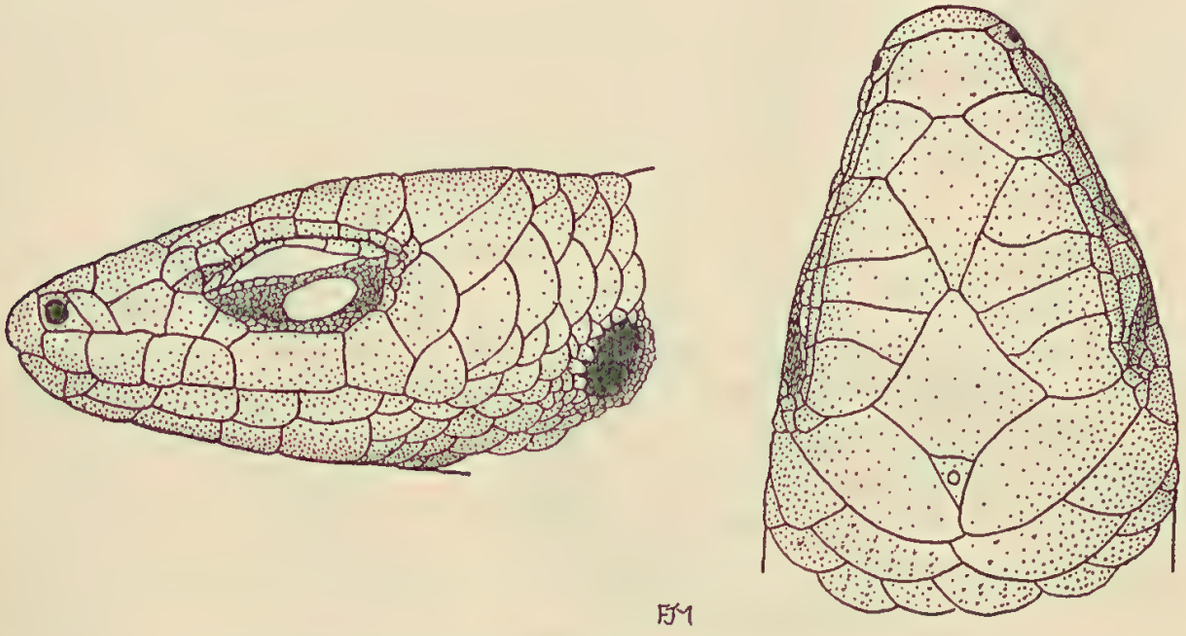

Fig. 1. *Leiolopisma vertebralis* (De Vis): dorsal and lateral views of the head of the lectotype (Q.M. J248).

Mr. G. Mack of the Queensland Museum kindly forwarded the following data on the remaining four specimens of the type series, "Dorsals bi-, tri- and quadricarinate, each keel being entire; laterals mostly bicarinate, but some tricarinate. Midbody scales in 23 rows (3 specimens) or 24 rows (1 specimen); lamellae beneath the fourth toe 23 (3 specimens) or 24 (1 specimen)."

The overall variation noted for the species is: midbody scales in 38 rows (5 specimens), 39 rows (2 specimens) or 40 rows (3 specimens); lamellar formula for the hind limb, 15-16, 22-24, 17-18, 13-14, 8; there is some variation in the percentage of tricarinate scales in the lateral region of the body.

The basic colouring of the recently collected South Australian Museum specimens is blue-green with the irregular darker patterning in the dorso-lateral and lateral regions defining a uniformly coloured vertebral stripe, comprising two adjacent series of pale blue scales. Ventral surfaces uniform pale blue.

LEIOLOPISMA COENSE sp. nov.

Fig. 2.

Leiolopisma vertebralis Loveridge (*nec.* De vis), 1934, p. 361.

Types: Holotype, M.C.Z. 37171 and one paratype, M.C.Z. 37170. Both specimens were collected at Coen in Northern Queensland by P. J. Darlington in May, 1932.

Diagnosis. Midbody scales in 36 or 38 rows; dorsal and lateral scales weakly tricarinate, each keel being broken up into a series of points (see fig. 3). Fifth upper labial largest, subocular; palpebral disk a little smaller than the ear opening, which has 4 or 5 short rounded lobules on the anterior border. Subdigital lamellae of 4th toe, 30-32.

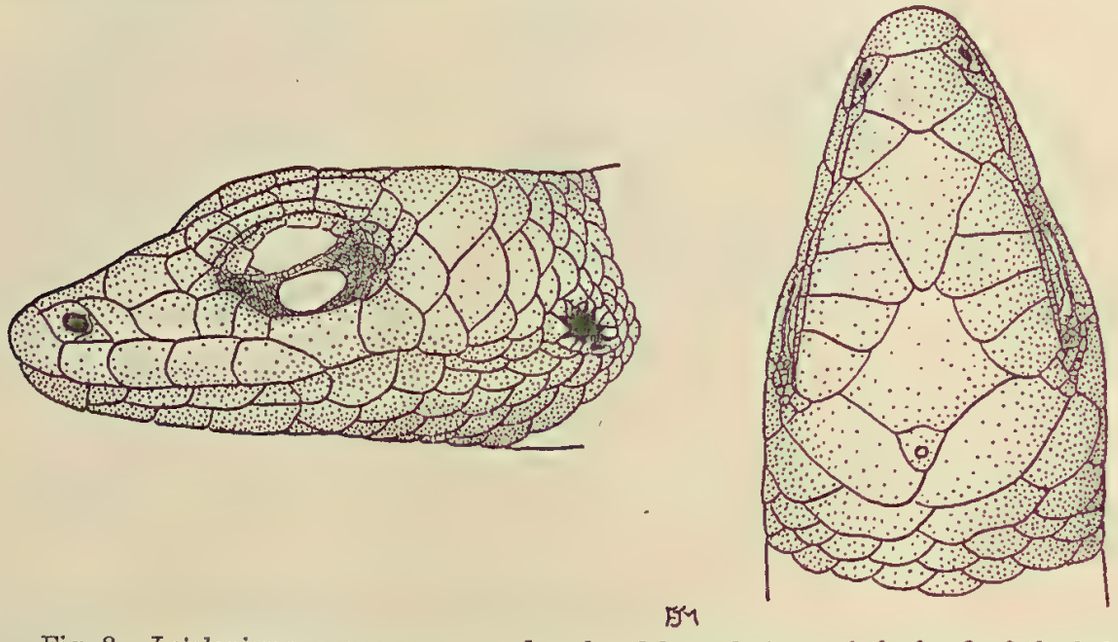

Fig. 2. *Leiolopisma coense* sp. nov.: dorsal and lateral views of the head of the holotype (M.C.Z. 37171).

Type description. Distance between the tip of the snout and the forelimb equal to that between the axilla and groin; when the hind limb is adpressed along the body the fourth toe reaches the axilla. Fronto-parietal single, interparietal distinct; prefrontals separated by a distance a little less than half the length of internasal-rostral suture. Four supra-oculars, seven or eight supraciliaries; one pair of enlarged nuchals; seven upper labials, fifth largest, subocular. Transparent palpebral disk a little smaller than the ear opening, which has four short rounded lobules anteriorly. Body scales in 38 longitudinal rows at midbody; dorsals and laterals weakly trikeeled, each keel being broken into a series of points. Digits slender, lamellar formula for hind limb, 20, 30, 25, 17, 10.

The dorsal colouring is dark chocolate brown with five longitudinal series of light blue rectangular spots, an almost continuous middorsal series, one extending from the posterior border of each eye along the body above the limbs to a point approximately one third the way along the tail and one from each ear to the forelimb and along the side to the groin. The dorso-lateral stripes are continuous on the nape but break up on the body. Ventral surfaces near white.

The holotype measures 107 (42 + 65) mm.—tail complete, but damaged.

Paratype variation. Unfortunately, the paratype specimen is badly crushed about the head, but the scalation detail discernible indicates that it agrees closely with the holotype. Midbody scales in 36 longitudinal rows, each dorsal scale possessing three of the characteristically broken keels. The subdigital lamellae vary a little, the lamellar formula for the hind limb in M.C.Z. 37170 being 22, 32, 24, 18, 10. The size, shape and prominence of the auricular opening and lobules are constant, while the only significant variation in the colour pattern is a slight difference in the continuity of the middorsal stripe.

Affinities. Loveridge (1934, p. 361) confused this species with *vertebralis* De Vis, from which it differs in the nature and constancy of the trikeeling, larger size of the ear with less prominent lobules, greater number of subdigital lamellae and in colouration.

LEIOLOPISMA TETRADACTYLA (O'Shaughnessy).

Mocoa tetradactyla O'Shaughn., 1879, p. 300.

Specimens examined. Q.M. J2631-2632, Toowoomba, south-eastern Queensland.

Variation. The two specimens examined possess thirty smooth scales at midbody. Prefrontals contacting on the midline or forming a short median suture. Ear opening small, oval; vertical diameter equal to half the horizontal diameter of the palpebral disk, which is equivalent to one third the length of the ocular slit. One large auricular lobule anteriorly and small denticularions on each side. Limbs short, stout, the hindlimb lamellar formula for these specimens being 12-13, 18-21, 14-16, 11-13, 7.

LEIOLOPISMA MACCOOEYI (Ramsay and Ogilby).

Lygosoma maccooeyi Ramsay and Ogilby, 1890, p. 8.

Specimens examined. Q.M. J7775-7777, Dubbo, New South Wales.

Variation. Body scales smooth, in 30-32 rows at midbody. Ear opening small, round, without obvious lobules; much smaller than the palpebral disk. Prefrontals and nasals separated. The subdigital lamellae vary as follows: hindlimb formula 13-14, 21-23, 16, 11-12, 8; forelimb formula 7-9, 12-14, 14-16, 9-10.

LEIOLOPISMA BICARINATUM (Macleay).

Heteropus bicarinatus Macleay, 1877, p. 68.

Heteropus albertisii Peters and Doria, 1878, p. 362.

Leiolopisma albertisii Barbour, 1914, p. 204.

Leiolopisma peronii Barbour (*nec.* Dumeril and Bibron), *op. cit.*

Specimens examined. Queensland. Q.M. J7779, Dunk Island, Rockingham Bay; S.A.M. R2877, R2973, R2983, Cairns; S.A.M. R2974, R2979, R2980, R2985-2987, Palm Beach, near Cairns; S.A.M. R2976, Port Douglas.

Variation. Midbody scales in 30 or 32 longitudinal rows; each dorsal and lateral scale strongly bicarinate, the keels forming longitudinal lines along the body. Ear opening almost round, diameter equal to or a little smaller than the mean diameter of the palpebral disk; with numerous acute lobules on all borders. Four labials anterior to the subocular. Lamellar formula for the hind limb, 15, 28-30, 19-20, 13-14, 7-8.

A black-edged pearl-white dorso-lateral line commencing at a point above the ear in line with the supraciliary ridge and continuing along the body to above the hind limb is prominent in three of the specimens from Cairns and the one from Port Douglas, but is very faint or absent in all other material examined. The white line follows a single longitudinal series of scales, keeping between the two keels.

LEIOLOPISMA RHOMBOIDALIS (Peters).

Heteropus rhomboidalis Peters, 1869, p. 446.

Specimens examined. Queensland: Q.M. J2493, S.A.M. R2965, R2989, Innisfail; Q.M. J7785-7787, Herbert River Gorge; S.A.M. R2959, R2962, Tully; S.A.M. R2960-2961, R2963-2964, Lake Eacham; S.A.M. R2987, Mount Hypipawea.

This species is readily distinguishable from its allies by the fusion of the frontoparietals and interparietal into a single rhomboidal shield.

Variation. Midbody scales weakly tricarinate; in 32 or 34 longitudinal rows at midbody. Palpebral disk approximately equal in size to the ear opening, which has two or three short rounded lobules anteriorly. Subdigital lamellae somewhat irregular, the hind limb formula varying 15-17, 23-28, 18-21, 11-12, 7 in the specimens examined.

Some evidence of a light dorso-lateral line is evident in all specimens, the line generally starting behind the eye and fading into the basic body colouring about half-way along the body. In this species the line is approximately one scale wide, and runs between two series of scales, each scale being half white.

LEIOLOPISMA NOVAEGUINEAE (Meyer).

Lygosoma (Carlia) Novae Guineae Meyer, 1875, p. 132.

Lygosoma laeve Oudemans, 1894, p. 144.

Lygosoma aeratum Barbour, 1901, p. 7.

Specimens examined. Queensland: Q.M. J7791-7792, Iron Range, Cape York Peninsula; S.A.M. R2972, Palm Beach, near Cairns.

Variation. Midbody scales in 22-26 longitudinal rows; dorsal and lateral scales perfectly smooth. Ear opening smaller than the palpebral disk, but variable in both size and shape; in S.A.M. R2972 it is surrounded by long acute lobules almost concealing the opening, as in *aeratum*, while in the Iron Range specimens only one obtuse lobule is present on the anterior border.

Faint signs of a dark-edged light dorso-lateral stripe are evident on the anterior half of the body in the two Iron Range specimens.

LEIOLOPISMA VIVAX (De Vis).

Heteropus peronii Dumeril and Bibron, 1839, p. 760 (suppressed as a homonym in the genus *Lygosoma*).

Myophila vivax De Vis, 1884, p. 77.

Heteropus blackmanni De Vis, 1885, p. 168.

Specimens examined. Northern Territory (Arnhem Land): U.S.N.M. 128507-128510, Milimgimbi Island, Crocodile Islands; U.S.N.M. 128257, Nightcliff, near Darwin; A.M. R13585 (4 specimens), R13586 (4 specimens), Cape Arnhem.

Queensland: Q.M. J7803, Noosa Heads, south-eastern Queensland; Q.M. J5640-5641, Lindeman Island, Cumberland Group; Q.M. J7772, Low Islands; Q.M. J7780-7781, Stannary Hills near Herberton; Q.M. J6328, J6332, Toogoom, via Torbanlea, North Maryborough; Q.M. J1308, Mount Coot-tha; Q.M. J7773, "No data, but probably one of the type series of *blackmanni* De Vis," which were collected at Port Curtis.

Variation. The Arnhem Land specimens displayed the following variation: Dorsal scales sharply bicarinate, becoming smooth or obtusely tri- or quadricarinate on the nape. Midbody scales in 28 rows (2 specimens), 30 rows (6 specimens) or 32 rows (4 specimens)—only the U.S.N.M. and S.A.M. specimens counted. Prefrontals narrowly separated or making point contact in the majority of specimens, but forming a definite median suture in two of the Groote Eylandt skinks. Interparietal very small; a single pair of enlarged nuchals. Seven

upper labials, fifth subocular. Ear opening variable in size, usually only about half the maximum diameter of the transparent palpebral disk; several short lobules anteriorly. The position of the posterior suture of the second supraocular is variable; this scale makes point contact with the frontal in several specimens. The frontal is fused with the frontoparietal in U.S.N.M. 128440. The subdigital lamellae counts show a variation of 22-26 for the fourth toe.

Metallic green to bronze dorsally with numerous, irregularly distributed, black-edged ocelli, recalling those of *Ablepharus lineo-ocellatus* Dum. and Bibr. Lateral surfaces light bronze; ventral surfaces white to pale blue; a black reticulate patterning along the ventro-lateral surfaces and under the throat of males.

The Queensland specimens examined showed similar variation, the significant points being: Midbody scales in 28 rows (1 specimen), 30 rows (6 specimens) or 32 rows (3 specimens); dorsal and lateral scales strongly bicarinate, becoming tri- or quadri-carinate, towards the nape; in some specimens as many as twelve distinct keels are present on the enlarged nuchals. Usually four labials anterior to the subocular, but occasionally only three, and in J5641, five. Ear opening noticeably smaller than the palpebral disk; with one or two rounded lobules anteriorly. The lamellar counts for the fourth toe are a little higher than those recorded for the Arnhem Land specimens, varying from 25-28.

The general colouration is more uniform and less metallic; little or no sign of the reticulate patterning in either sex. A light lateral stripe is faintly visible in three specimens.

LEIOLOPISMA PECTORALIS (De Vis).

Carlia melanopogon Gray, 1844, pl. vii, fig. 1 (homonym in the genus *Lygosoma*).

Heteropus lateralis De Vis, 1885, p. 168 (homonym in the genus *Lygosoma*).

Heteropus pectoralis De Vis, 1885, p. 169.

Heteropus mundus De Vis, 1885, p. 172.

Lygosoma devisii Boulenger, 1890, p. 79 (n.n. for *lateralis* De Vis as preoccupied in the genus *Lygosoma*).

? *Lygisaurus foliorum* De Vis, 1884, p. 77.

Specimens examined. Northern Territory: U.S.N.M. 128764, Oenpelli; U.S.N.M. 128528, Port Essington; S.A.M. R2696, R2699, R2703, Adelaide River; Q.M. J2619-2620, J7789, Darwin.

Queensland: Q.M. J1414, Port Curtis (holotype of *H. pectoralis* De Vis); Q.M. J234, North Pine River (holotype of *H. lateralis* De Vis); Q.M. J7782-7784,

Stannary Hills, near Herberton; Q.M. J2462, Herbert River Gorge; Q.M. J6287, J6329, Toogoom, via Torbanlea, North Maryborough; Q.M. J2403, Magnetic Island, off Townsville; Q.M. J7774, Gregory River.

Unfortunately the type specimen of *Lygisaurus foliorum* De Vis could not be located in the Queensland Museum and therefore its position remains in doubt.

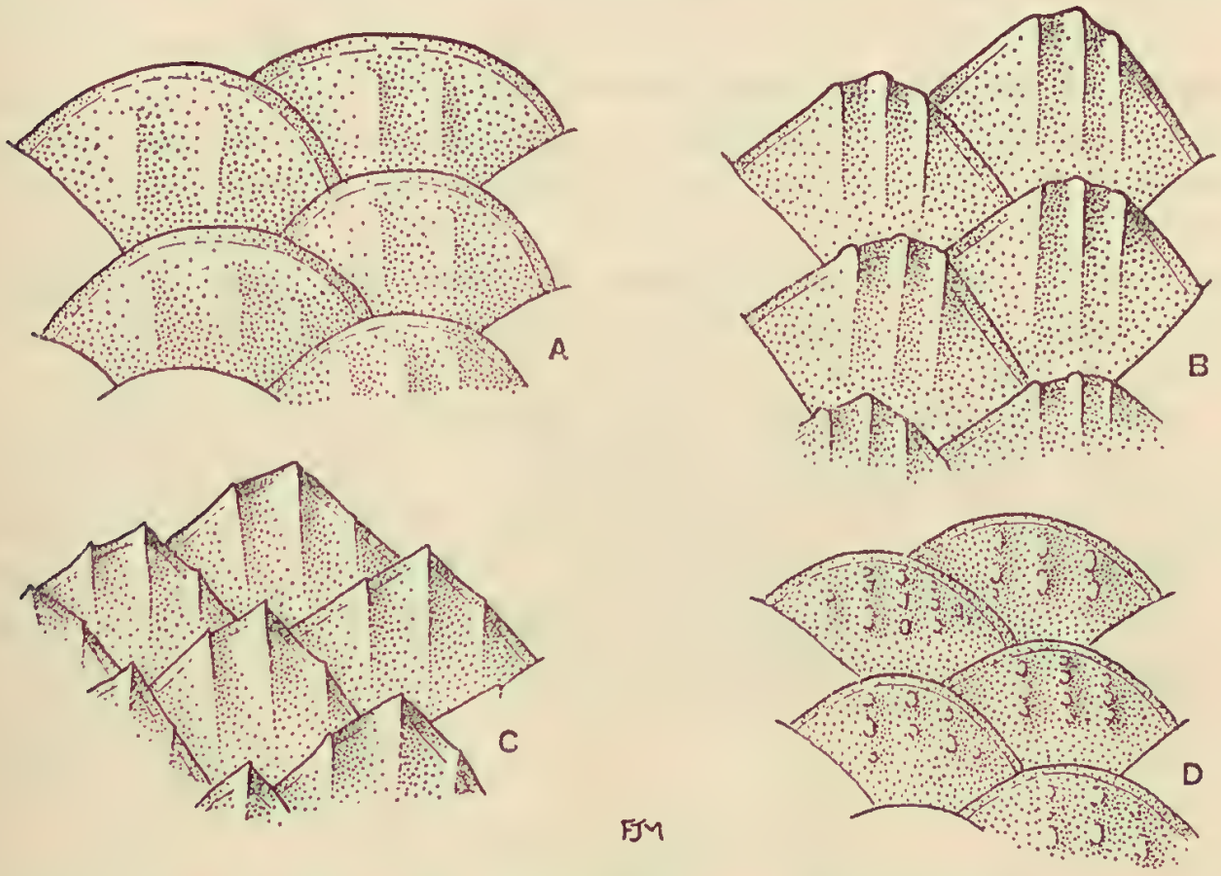

Fig. 3. Drawings illustrating the middorsal scales of (a) *Leiolopisma vertebralis* (DeVis); (b) *Leiolopisma pectoralis* (De Vis); (c) *Leiolopisma triacantha* sp. nov.; and (d) *Leiolopisma coense* sp. nov.

Variation. Midbody scales in 26 rows (U.S.N.M. 128764), 28 rows (3 specimens), 30 rows (11 specimens) or 32 rows (5 specimens). Four, occasionally five, upper labials anterior to the subocular, five to seven supraciliaries. Ear opening usually without prominent lobules, but one or two short rounded ones are evident on the anterior border in several specimens. An average lamellar formula for the hind-limb is 14, 24, 19, 11, 7, the specimens examined showing a variation of 22-29 in the number of lamellae beneath the fourth toe.

General colouration varying from uniform brown to grey-green with silver-grey dorso-lateral and occasionally lateral stripes. These longitudinal stripes are discontinuous in the Adelaide River specimens.

Q.M. J6287 is a gravid female containing two eggs. It measures 95+ (41 + 54+) mm.— tail incomplete.

Discussion. The specimens examined support the opinion of Loveridge (1934, p. 363) that *pectoralis* De Vis and *mundus* De Vis are synonymous with *melanopogon* Gray, and that this species shows wide variation in the prominence of the keeling on its dorsal and ventral scales, as does its near ally, *fuscum* Dumeril and Bibron. An examination of the type specimen of *lateralis* De Vis (Q.M. J234) indicates that the name belongs in the synonomy of this species rather than that of *peronii* Dumeril and Bibron (= *vivax* De Vis), to which it was doubtfully referred by Boulenger (1887, p. 286).

The holotype of *Heteropus pectoralis* De Vis (Q.M. J1414) was also re-examined and the following details were noted as being discrepant with the type description. The midbody scales are in 30 and not 32 longitudinal rows and there are eight upper and eight lower labials, five of the upper labials being anterior to the subocular. The colouring of the type has faded beyond recognition.

The type specimen of *Heteropus mundus* De Vis could not be located, but Q.M. J7774 was identified by De Vis as belonging to this species. It corresponds closely with De Vis' short type description, differing from the type of *pectoralis* in possessing only seven upper labials with four anterior to the subocular, and in lacking the distinct trikeeling on the dorsal scales, the only evidence of this being striations visible when the scales are viewed under oblique light. Midbody scales in 30 rows and subdigital lamellae 23-24 on the fourth toe in both specimens.

LEIOLOPISMA TRIACANTHA SP. NOV.

Holotype: S.A.M. R2697, a sub-adult male taken at Adelaide River, Northern Territory, and collected by Dr. R. V. Southcott, in June, 1943.

Paratypes: S.A.M. R2700, R2702, Adelaide River, Northern Territory; Q.M. J7788, Darwin, Northern Territory.

Diagnosis. Midbody scales in 30 or 32 longitudinal rows, each dorsal scale being strongly tricarinate and of characteristic form (see fig. 3). Ear opening without obvious lobules; approximately two-thirds the horizontal diameter of the palpebral disk.

This species appears to be most nearly allied to *pectoralis,* differing in the nature of the dorsal scales and in possessing a median prefrontal suture.

Type description. Distance between the end of the snout and the forelimb equal to that between the axilla and groin. Adpressed hind limb reaches a point between the axilla and the ear opening. Frontoparietal single; interparietal distinct; prefrontals forming a median suture equal to one third the

internasal-rostral suture. Four supraoculars, second largest and forming sutures with both frontal and fronto-parietal; six supraciliaries. Seven upper and seven lower labials, the fifth upper labial largest and subocular. Ear opening crescent shaped, without obvious lobules on the anterior border, but with a denticulate posterior edge (see fig. 4); its horizontal diameter is two-thirds that of the palpebral disk. One pair of enlarged nuchals and a pair of enlarged anal scales present. Thirty-two rows of scales at midbody, the dorsals and laterals being strongly tricarinate, some middorsals incipiently tricuspid; ventral scales mostly smooth although faint trikeeling is evident in some ventro-lateral scales.

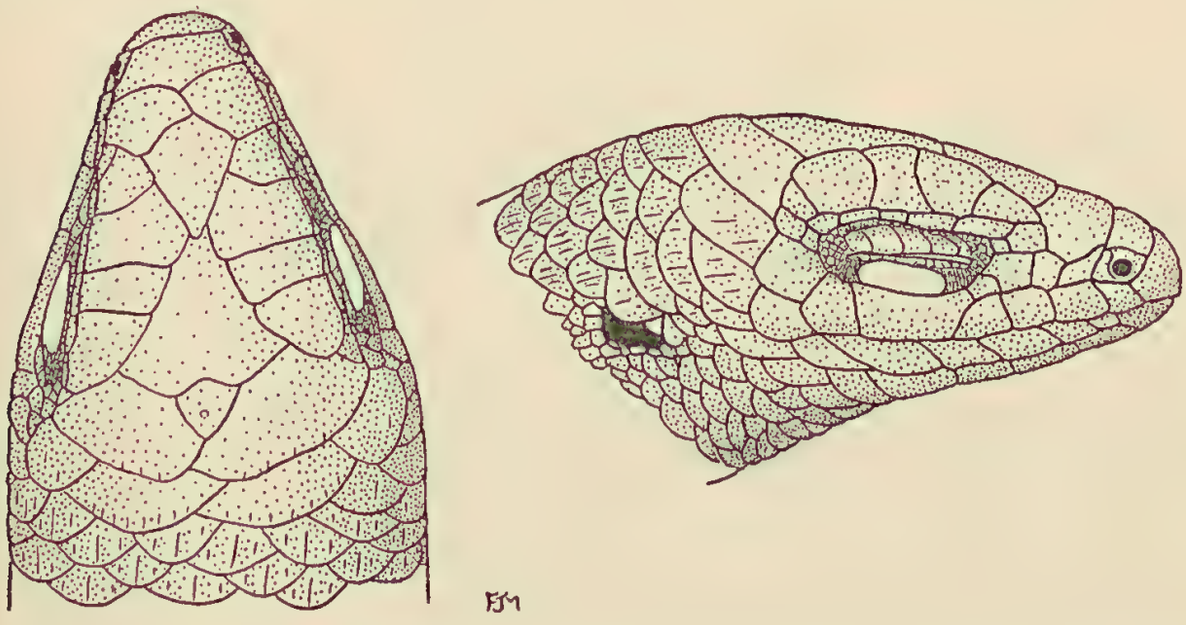

Fig. 4. *Leiolopisma triacantha* sp. nov.: dorsal and lateral views of the holotype (S.A.M. R2697).

Subdigital lamellae rounded, the hind- and fore-limb formulae being 14, 23, 17, 10, 7 and 11, 17, 15, 7 respectively. The reproduced section of the tail has laterally expanded upper caudals.

Measurements. 79 (36 + 43) mm.—tail reproduced.

Colour. The colouring of the type is iridescent blue-green dorsally with irregularly distributed black-pointed scales, these being most numerous on the tail. Ventral surfaces pearl-white.

Variation. The paratypes show few differences from the type. Midbody scales in 30 or 32 rows; 22-24 lamellae beneath the fourth toe. Seven or eight upper labials with the fifth constantly subocular; six or seven supraciliaries. Median prefrontal suture constantly one-third the internasal-rostral suture.

SUMMARY.

The type specimens of certain species described by W. Macleay and C. W. De Vis have been re-examined and compared with 134 specimens from Queensland and Northern Territory in an endeavour to stabilize some of the scientific names and synonymies of species in this group. Numerous changes are made in the synonymies, and *Leiolopisma coense* and *Leiolopisma triacantha* are described and figured as new species. The lectotype of *Leiolopisma vertebralis* (De Vis) is also figured.

A dichotomic key has been constructed for the Australian species and races.

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17 JUN 1954

MATERIAL CULTURE OF AUSTRALIAN ABORIGINALS

PART 1. PROGRESSIVE MODIFICATION OF A STONE ARTEFACT

PART 2. INCISED STONES FROM SOUTH AUSTRALIA

By H. M. COOPER, ASSISTANT IN ETHNOLOGY, SOUTH AUSTRALIAN MUSEUM.

Fig. 1-26.

SUMMARY.

THIS paper discusses briefly, in part 1, the diminution in size and alteration in shape of the Tula and other closely related adze-stones of the Australian aboriginals, resulting from wear and re-trimming. Mention is made of the important bearing which the relative abundance and scarcity of material, suitable for their manufacture, appears to have upon the numerical extent of their occurrence. Reference is also made to the subsequent improvization of an implement, differing in form from the original, fashioned from apparently discarded worn examples of suitable shape. In part 2 Incised Stones from the Artipena and Yudnapunda Hoards are described, together with a brief but general discussion regarding their possible use and significance, both of which continue to remain indeterminate. A series of drawings, illustrating examples of their characteristic pattern markings, is shown.

PART 1.

Adze-stones, semi-discoidal in shape, differing but little in technique of manufacture and design, may be found upon abandoned native camp-sites in many parts of Australia; some, in fact, continue to be made and employed in the more remote and isolated parts of the Continent where the Stone Age culture of primitive man persists amongst groups of our surviving aboriginals.

The zenith of master craftsmanship attained in the production of this type of implement, represented by the true Tula adze-stone industry, appears to have existed in certain portions of the Lake Eyre Basin, including the territories formerly occupied by the Wongkanguru, Dieri and neighbouring tribes. Variously coloured cherts, jasper, agate, porcellanite, fine-grained quartzites and other products of these and adjoining arid regions—all of which produce an excellent

conchoidal fracture when struck—provide material worthy of association with so skilful a culture.

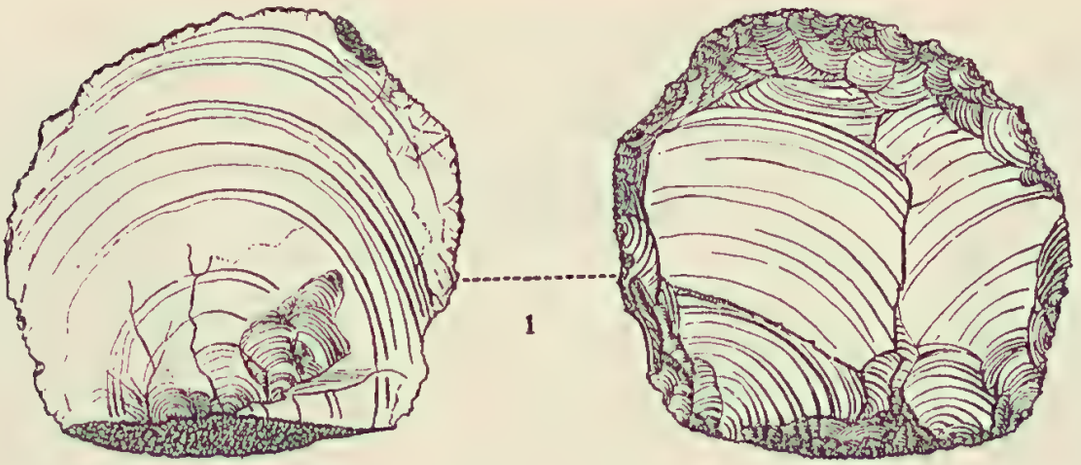
Horne and Aiston (1924) introduced the word "Tuhla" in order to describe this beautifully made implement, but subsequently the spelling was altered to "Tula" by Hale and Tindale (1930) as being more in consonance with the phonetic system.

Fig. 1, illustrating a typical example of the Tula adze-stone, shows little if any evidence, either in its shape or form, of wear from use and necessary re-trimming; it may be regarded, therefore, as a specimen in almost new condition. The head or working edge, situated upon the upper surface of the implement (at the opposite end to the base which, in all cases, is also the point of percussion), is stoutly convex in section in order to anticipate provision for future wear, and shows strong edge and associated stepped trimming; the remainder of the periphery being secondarily trimmed in most cases but to a lesser degree. The flake, which upon its under or nether side is comparatively flat, as the drawings indicate, was detached from the parent core by means of a single fracture and needed no further trimming upon that surface.

The adze-stone of the Australian aboriginals was mounted in and held securely by a mass of gum at the extremity of a comparatively short, stout wooden stick, about 50–60 cm. in length, and also at the handled end of certain spear-throwers, more especially the broad-bladed type of Central Australia. When removing the adze-stone for sharpening and further trimming or resetting, the process was simplified by softening the gum. Such adze-stones, including the Tula, mounted in this manner, were employed when in operation similarly to the handled European metal adze, that is, with a chopping motion directed towards the operator. They were highly efficient in the hands of a skilled native craftsman and capable of producing beautiful work. Food vessels, shields, spear-throwers, boomerangs, spears, clubs, digging sticks and tjurungas, besides the many other domestic, hunting, fighting and ceremonial impedimenta, all so essential in the every-day life of the aboriginals of Australia, both in camp and afield, were fashioned with the aid of this very effective implement.

Horne and Aiston (1924) remark that during the process of shaping a boomerang the native tradesman trims the Tula from time to time as its edge becomes blunted, by means of a hammerstone, until it is discarded and a fresh implement inserted in the gum. A good Tula, they add, was capable of fashioning at least two boomerangs.

In consequence of continued use and the resultant symmetrical re-sharpening of the working edge to compensate for it, the Tula is gradually but evenly



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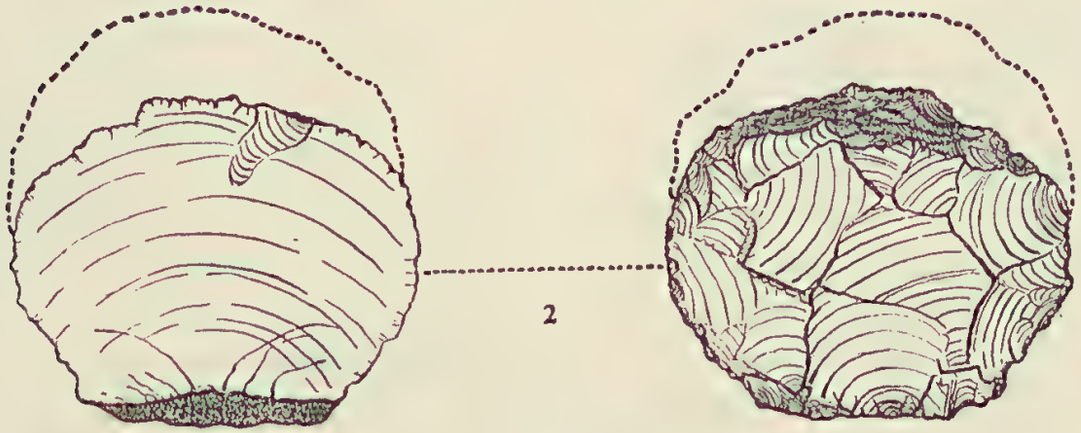

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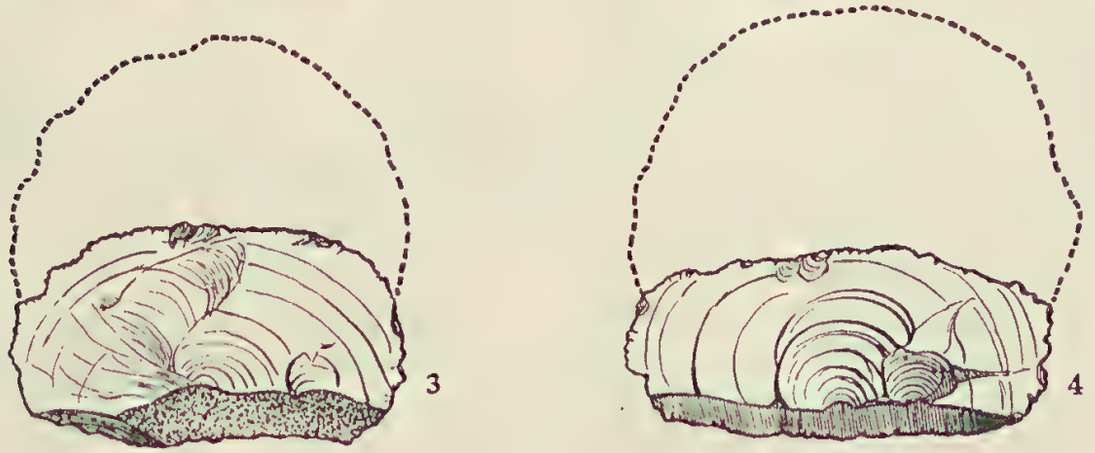


3 4

5 6

diminished in size and shape in the direction of its base, as shown in fig. 2–6, until it finally attains that state of diminution where it is no longer practical to embed it firmly in the gum or continue its employment economically. The apparently deliberate use of discarded examples, such as shown in fig. 6, for conversion into a new design is referred to later in this paper.

Semi-discoidal adze-stones of the Tula and closely related types appear to have been especially dominant in certain specific but often widespread localities such as the Far North of South Australia, including the Lake Eyre Basin, areas around Stuart's Creek, Arcoona, portions of Central Australia, South-Western Queensland, Western New South Wales, South-East of South Australia and parts of Yorke's Peninsula in the vicinity of Moonta and Black Point.

The retention of Tulas for as long as possible, particularly those made from the more highly prized material, is clearly shown by the presence of large quantities of worn specimens found strewn upon many now long-abandoned camp-sites. The relative scarcity or abundance of suitable material appears to have a significant bearing upon the ratio of discarded to still serviceable examples. The three analyses which follow, in association with comparable ratios from other sites, tend, perhaps, to confirm this theory.

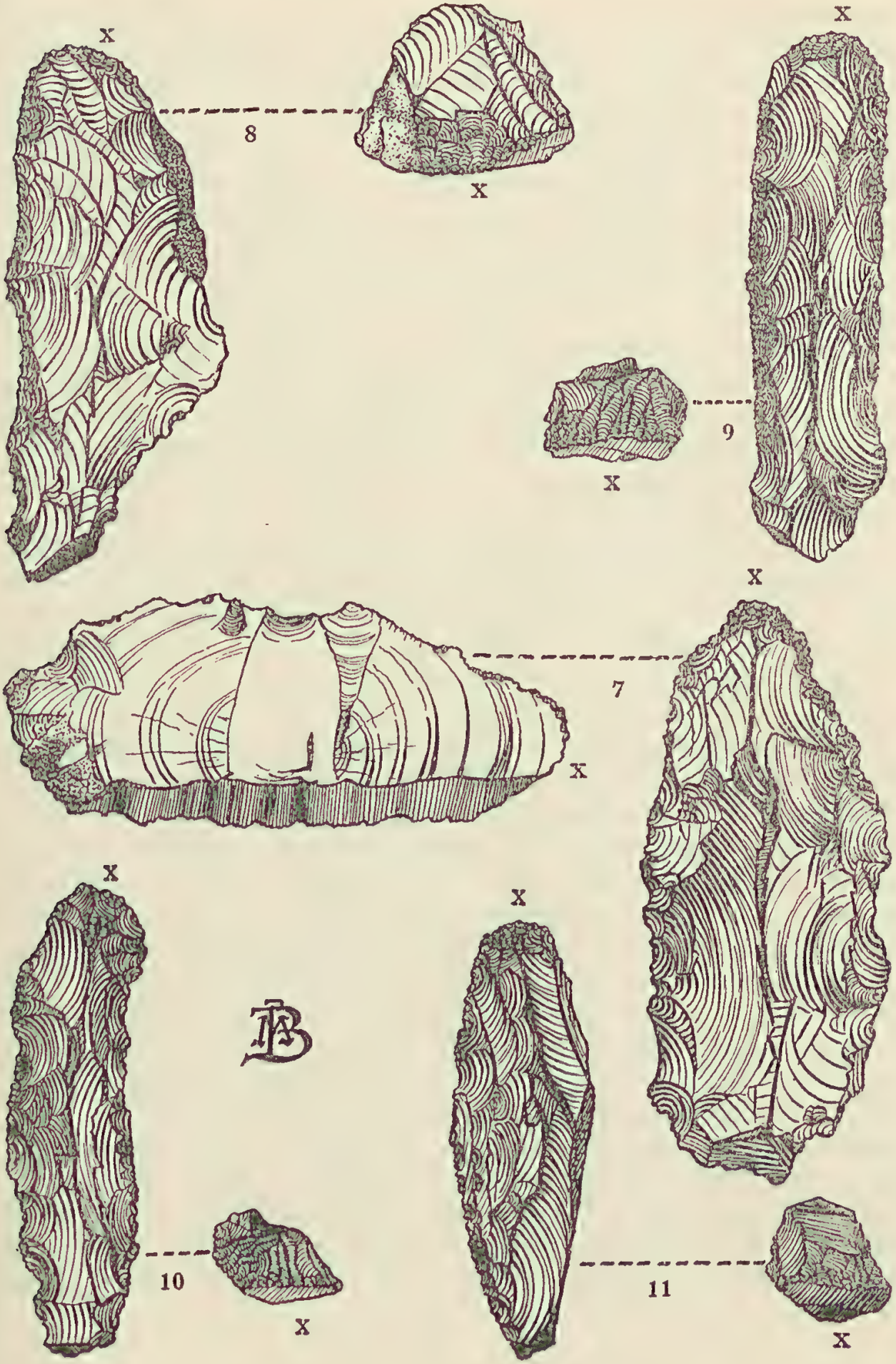
An examination of material secured recently upon an extensive camp-site previously unnoticed at Oolarinna Waterhole, west of Oodnadatta, by an experienced collector, included the following:

Tula adze-stones, approximating fig. 1 and 2	74
Evenly worn examples, such as in fig. 3-6	392

A small number of specimens represented successive and intermediate stages of wear. These figures appear to indicate that material in certain localities was highly prized owing to difficulty in replacement.

During the course of seven visits to Emu Springs, Wirrealpa Station, by the present writer, 279 adze-stones, many showing no more than partial but very irregular diminution in size and shape due to use, were secured, together with only 29 evenly worn, trimmed examples, such as shown in fig. 3–6. The presence of an extensively worked near-by native "stone quarry," and in consequence the abundance of suitable rock, would appear to account for both the scarcity of totally worn symmetrically re-trimmed examples and the presence of so many implements apparently rejected early in their lives, in preference to adjusting the effects of wear by means of further trimming and consequent rejuvenation.

Extensive camp-sites in the South-East of South Australia provide an additional significant indication of what could be termed an example, primitive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it is true, of the application of a law of supply and demand in its simplest form. Although the collection from that area in the South Australian Museum embraces several hundred examples of semi-discoidal adze-stones, no symmetrically re-trimmed worn types, such as fig. 3–6 denote, could be found with the exception of one specimen from Woakwine Range, possibly wrongly labelled. There exist, however, in this collection, several thousand adze-stones from the same area worn by use to an irregular and only moderately reduced size and then apparently discarded, an inexhaustible supply of local flint, excellent in its texture, rendering any need for prolonging their usefulness by symmetrical trimming unnecessary.

The absence here of highly-worn re-trimmed examples might indicate, perhaps, in addition, that to the skilled craftsman the fashioning of new implements where material was easily available for replacement purposes, was a labour of little consequence. The presence of many partly worn adze-stones of similar irregular shape at Emu Springs, with its abundance of local stone, may be comparable in its inference.

The existence, therefore, of large quantities of adze-stones, carefully and progressively re-trimmed to the utmost limit of their useful life, upon certain camp-sites, provides an interesting example of practical economy, dictated, not by choice, but by stern necessity.

Some collectors, influenced perhaps by the symmetrical shape of trimming applied to examples reduced in size, step by step, owing to wear, such as shown in fig. 3 and 4, have inclined towards the belief that they may represent a totally different type of implement to the semi-discoidal adze-stone. However, a careful examination of many hundreds of specimens gradually reduced in dimensions down to fig. 6, including some still mounted *in situ* at the gummed ends of their wooden handles, appears to indicate without doubt that all represent successively worn stages of original forms such as shown in fig. 1.

Tulas and other types of implements, fashioned from the more highly prized material such as cherts, porcellanite, jasper and fine-grained quartzites, may be found upon camp-sites far distant from their nearest natural source of supply, doubtless reaching their various destinations, along with other bartered products, by way of the elaborate network of trade routes then existing. Where suitable local stone was non-existent, they represented, therefore, the only material available, and even when rock of an inferior nature was obtainable near-by the traded examples of superior quality were employed as a welcome addition to supplement it. The presence of cores and blocks of such traded stone upon certain camp-sites suggests that the unfinished raw product was secured by "importation" additionally to the completed article.

Although an examination of over one thousand worn adze-stones in the South Australian Museum collection appears to convey the impression that most specimens, upon attaining the state depicted in fig. 6 were finally discarded as no longer economically or practically efficient, a comparatively small proportion of the requisite shape appears to have been retained and adapted to a further period of usefulness by transformation, with considerable skill and improvization, into long end-scrapers. Such implements, shown in fig. 7-11, would perform admirably in producing the beautifully symmetrical scribing, grooving and fluting with which the natives in some districts delighted to adorn and decorate their food vessels, shields, spear-throwers, boomerangs and clubs.

A comparison of figured specimens 7 to 11, with typical examples of the long end-scraper found so abundantly in association with them upon Far Northern South Australian camp-sites, indicates, significantly, identical trimming, and in consequence the possibility that both types may have been in use contemporaneously.

An examination of the relatively small collection of worn adze-stones from Western New South Wales and South-West Queensland, possessed by the South Australian Museum, is suggestive of the probable existence of this interesting improvized implement in those and other areas.

PART 2.

Incised stones of unknown significance, such as illustrated in fig. 12-26, were first referred to by Mountford (1938) and subsequently by Cooper (1947 and 1948). In the earlier of the papers by the latter, the writer expressed a hope that, as a result of attention drawn to the existence of this interesting material, definite proof might be forthcoming regarding its use and also some information more clearly defining the localization or extension of their present known occurrence—a realization which, unfortunately, has not been attained. Little fresh evidence, therefore, is available for inclusion in this paper with the exception of a description of the Artipena and Yudnapunda Hoards; certain information, however, previously known regarding these incised stones, is added in order to assist those unfamiliar with them. For a more detailed description the reader is referred to Cooper (1947) wherein the figured drawings still adequately represent the principal arrangements of incisings upon the specimens, now increased from 70 to 200, including the Yudnapunda Hoard, lately transferred to the South Australian Museum.

With the exception of a few scattered examples, found in adjacent mountainous regions to the westward and south, the 200 known specimens were

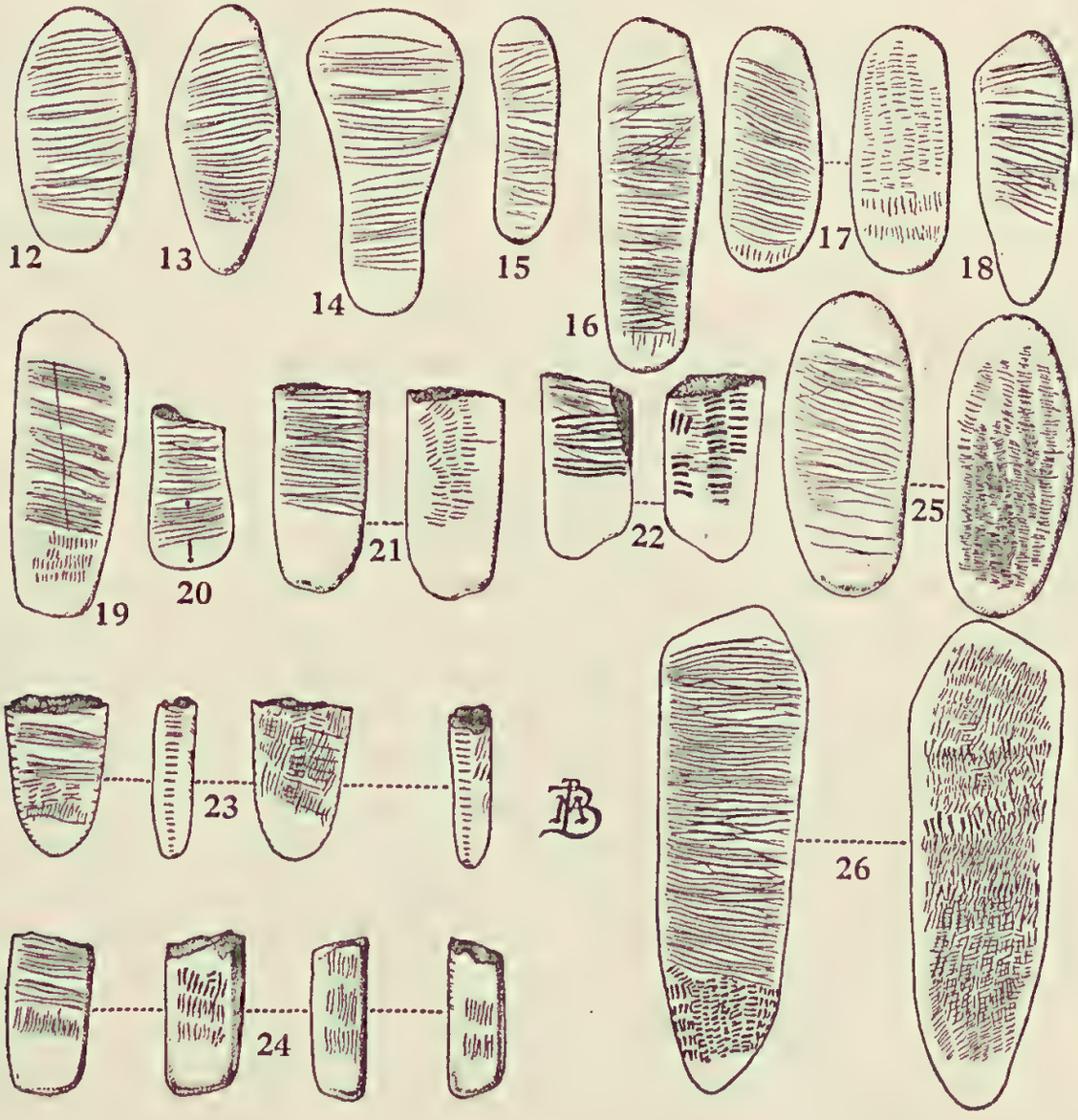
collected upon former camp-sites, amidst saltbush plains, lying in the area to the south-westward of Lake Frome and east of the Flinders' Ranges, more especially in pastoral country situated within Martin's Well Station, along sections of the Wilpena Creek and its tributaries. This district, the former home of the Jadliaura Tribe, long since extinct, is typically arid in its aspect and has a six-inch annual rainfall but is liable to severe and prolonged droughts. The vegetation includes Mulga *(Acacia aneura)*, Black Oak *(Casuarina cristata)*, various species of Saltbush *(Atriplex)* and other arid country plants. Splendid specimens of the Red Gum *(Eucalyptus camaldulensis)* line the creeks, more especially in the vicinity of permanent waters. The district is drained by several streams of considerable size, including Wilpena, Balcoracana and Wirrealpa Creeks; all in times of infrequent but heavy flood carry immense volumes of water into Lake Frome. During all other periods their channels, with the exception of scattered permanent water-holes and springs situated in their beds, are dry and parched. Many incised stones, including the Artipena and Yudnapunda Hoards, were found upon the banks of Wilpena Creek and its network of tributaries.

Incised Stones, with the exception of a few examples either cylindrical or angular in shape, consist of small flat water-worn stones derived from fine-grained silt-stones and silty clay shales, countless numbers of which exist in the beds of local creeks and upon their banks. All examples found bearing incisings are of natural shape with no evidence of artificial trimming; they vary in weight from ½ an ounce to 6½ ounces, with an approximate average of 2⅜ ounces.

THE ARTIPENA HOARD. Upon the banks of Artipena Water, situated in the bed of Wilpena Creek, is an extensive camp-site upon which have been discovered, along with other material, large and primitive trimmed water-worn pebble hand choppers, identical both in shape and technique of manufacture with the archaeological Kangaroo Island Industry, referred to by Cooper (1943). Numerous stone cooking hearths, extensively scattered in all directions, indicate the existence in former times of an important native occupation. The Artipena Hoard, comprising 19 specimens, was found within a small area upon this camp-site. In addition, some interesting examples were discovered in scattered places upon the banks of Artipena Water in association with various types of stone implements; they include fig. 25. The arrangements of the incisings, together with those of the Yudnapunda Hoard, are referred to elsewhere in this paper.

THE YUDNAPUNDA HOARD. Yudnapunda Springs, situated just outside the foothills of the Flinders' Ranges in the bed of a small gum creek which later joins Wilpena Creek, form a fine permanent water which, during the visit of

the present writer in company with a native station hand in 1950, when the hoard was discovered, was flowing strongly for more than a quarter of a mile. A former camp-site, somewhat scantily supplied with the larger and more primitive stone implements such as trimmed cores and blocks and simple flakes, many highly weathered and probably archaeological, was found upon its banks.



The Yudnapunda Hoard of incised stones, including fig. 18-24, was scattered upon the surface within an area having an estimated radius of 15 yards. The total collected comprised 73 specimens of which 59 are broken and incomplete, and only two of these could be restored by re-construction to their original form by means of their respective parts. It is impossible to determine whether these restorable examples were already broken when deposited where found or

whether their present damaged state could be attributed to subsequent climatic conditions. A careful search failed to locate any missing portions of the remainder. The possible significance of the presence of so many broken examples is referred to in a subsequent paragraph.

GENERAL DISCUSSION.

A casual or superficial examination of representative specimens of all the incised stones under review may appear to convey an impression of purposeless and haphazard markings, but upon closer inspection there is strong evidence of preconceived and deliberate intention, interpreted by at least several clearly-defined and alternatively utilized pattern markings. In order to examine these markings more fully, the specimens figured in Cooper (1947) will assist. The drawings in this present paper refer, necessarily, to material found in the two hoards, which, unfortunately, is somewhat circumscribed in the diversity of its patterns.

The markings of the incised stones occur either upon one side only or upon both, the totals in each case being approximately equal. In rare cases, such as fig. 23 and 24, they are present, in addition, along the edges. The length, direction and form of the lines, used in the production of the incisings generally, comprise the following arrangements: long transverse lines, more or less parallel but sometimes rarely in spaced groups such as fig. 19: very short transverse: very short longitudinal. Extended longitudinal markings are uncommon and consist chiefly of a single line as in fig. 19. These various lines are utilized in producing certain patterns, some complex, of which the following are those most frequently found: long transverse lines alone, as in fig. 12-15: short transverse alone, fig. 21, second face: short longitudinal alone, fig. 24, second, third and fourth faces: long transverse in association with short longitudinal, fig. 19 and fig. 24, first face.

Examples combining long and short transverse markings occur sparingly, as also do patterns which associate long and short transverse coupled to short longitudinal lines as in fig. 26, first face, and finally, a concurrence of short transverse and short longitudinal, fig. 17 and 26, both second faces. In no case has the present writer discovered an incised stone exhibiting long transverse markings such as shown in fig. 12 to 15, upon *both* of its sides; the markings upon the reverse surface of all these examples consisting, invariably, of short transverse or longitudinal lines, either alone or in association.

Occasional stones, such as fig. 22, exhibit dual or superimposed incisings,

one superficial and the other deeply cut. They appear to have been applied at different periods, similarly to carved designs recorded upon certain rock faces. Figures 25 and 26, included to indicate the amount of incising involved in unusual cases, illustrate, in addition, the patient application of their creator.

The various arrangements of incisings described above, appear to be far too deliberate in the constancy of their use to permit the investigator any thought of rejecting the belief that they represent some very real intention of purpose.

Any definite conclusion or even assumption regarding the use or purpose for which incised stones was intended, is hindered by the lack or almost complete absence of corroborative evidence upon which to base a decision; the best, therefore, which can be attempted at the present time is to consider, perhaps, certain tentatively possible uses to which this interesting culture were applied. The present writer has been unsuccessful in tracing, amongst records regarding the aboriginals of Australia, any reference relating to incised stones, similar to or resembling those under discussion, with the exception of a single example to be described later, and this could imply, in consequence, that they were not in general use throughout the Continent at any time since the commencement of the European occupation. It is possible, therefore, that either they will be found in a local and restricted area, where their use has passed unnoticed, such as their incidence at the present time appears to suggest, or that the culture will prove to be archaeological.

Of three specimens received by the South Australian Museum a considerable time ago, one is endorsed, somewhat vaguely: "Message stone, sent from one tribe to another with an accompanying verbal message; Northern Flinders' Range." The use of wooden message sticks by some Australian tribes is well established and has been referred to by several writers, including Roth (1901), Howitt (1904) and R. Hamlyn-Harris (1918), but owing to much conflicting evidence the actual significance of the markings is somewhat obscure. It appears probable, however, that the incisings upon the sticks, in many if not all cases, merely represent a tally or some general indication of the kind of message with which the carrier has been entrusted, for delivery verbally in detail, and is, in addition, a proof of his own *bona fides*. Despite the little similarity of the markings upon the wooden message sticks, in comparison with incised stones, the latter as regards convenience in transportation, at least resemble the former in approximate length. Message sticks, however, are not comparable generally in shape with incised stones, which, in addition, owing to the softness of the material utilized, would be prone to damage when carried from place to place. The presence of countless numbers of flat stones, so readily available, identical in shape and poorness of texture with examples selected for manufacture into

incised examples, probably influenced the natives in the selection of this material, ease in securing it overriding the inferiority of its structure. This adverse condition alone, however, should not influence the observer unduly by dismissing the possible use of the latter as "message stones."

The significant presence of so many broken examples amongst the Yudnapunda Hoard, and other incomplete specimens secured upon an abandoned camp-site near Wirrealpa homestead, together with the absence of the necessary broken parts to reconstruct them, is the result of some unknown contributory cause; a possible explanation could be damage whilst serving as a "message stone."

It is unfortunate that the only recorded information known to the present writer relating to the possible use of incised stones, is the vague record as stated above, but since this particular specimen was found in the Northern Flinders Ranges—the source of several others—their employment as "message stones" to denote some unknown interpretation merits consideration.

In proposing any alternative uses, several suggestions, all problematical, present themselves, such as some association with the social, cultural or ceremonial fields. They could represent, perhaps, a primitive type of tjurunga or possess some affinity with the mystifying cylindro-conical stones which sometimes bear similar markings, or finally, they may be phallic in their meaning.

The difficult problem which at the present time appears to surround the origin and use of the Incised Stones of South Australia provides an interesting and fascinating field for future investigation.

Localities of the specimens figured are as follows:

1. Mern Merna.
2. Goolong Springs, S.E. of Marree.
3. Stuart's Range.
4. Muloowurtina.
5. Cooper's Creek.
6. Callabonna.

7 to 11. Oolarinna Water-hole.

12 to 17. Artipena Water.

18 to 24. Yudnapunda Springs.

25. Artipena Water.
26. Salt Creek, Martin's Well.

These drawings were made by one of the South Australian Museum artists, Miss M. P. Boyce, to whom best thanks are due.

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FOUR NEW FISHES FROM SOUTH AUSTRALIA

By TREVOR D. SCOTT, B.Sc., Marine Biologist, South Australian Museum.

Plate xxii and text fig. 1-3.

SUMMARY.

Four new species of fishes from South Australia are described and figured. *Threpterius maculosus* Richardson and *Trygonorrhina fasciata guanerius* Whitley are redescribed, and keys are given for the Urolophidae and Gobiesocidae, known to occur in South Australia.

Family UROLOPHIDAE.

This family contains one genus, *Urolophus*, characterized by the rather short muscular tail, terminating in a well developed caudal fin. A small adipose dorsal fin may be present or absent.

Key to the UROLOPHIDAE of South Australia.

1. Disc broader than long 2
   Disc longer than broad 3
2. Nostrils with broad and prominent posterior lobes ..... *testaceus*
   Nostrils with small and inconspicuous posterior lobes ..... *expansus*
3. Spiracle of moderate size; disc with cruciform markings ..... *cruciatus*
   Spiracle very large, more than twice as long as eye, disc spotted *gigas* sp. nov.

Genus Urolophus Muller and Henle.

Urolophus Muller and Henle, 1836, p. 117 (Orthotype, *Raja cruciata* Lacepede).

Urolophus gigas sp. nov.

Plate xxii.

Snout very obtusely pointed, disc oval, slightly longer than broad. Length of disc 420 mm. (1·7), width 385 (1·8) in the total length 698 mm. Skin smooth. Eye small, length 14 (3·3) in the interorbital width 47. Spiracle very large, length 29, width 18, projecting forward below to middle of eye. Tail short and muscular, length 265. Width of tail 38 at posterior insertion of

ventrals. Preocular length 110, greater than preoral length 98. Width of mouth 55, teeth small and flattened. Width of internasal valve 58. Ventral fins rather short, length equal to width of mouth.

Adipose dorsal fin small, height 10, length of base 28. Spine originating immediately behind posterior margin of dorsal fin. Origin of spine 112 from tip of caudal fin. Last gill opening only slightly behind middle of pectoral disc.

Colour. Central part of disc, tail and caudal fin dark brown, fading to light brown pectoral flaps, margin of disc off-white. A pattern of small cream spots bordering disc, passing along tail to the caudal fin. Spots aggregated to form irregular circular markings covering parts of the disc. Ventral fins bluish-grey. Ventral surface white, with a wide border coloured warm brown.

Described from a female specimen measuring 698 mm. total length, taken January, 1952, at Port Noarlunga, South Australia. Type in South Australian Museum, Reg. No. F2744.

FAMILY RHINOBATIDAE.

Body, head and tail depressed. Disc broad behind, tapering anteriorly. Orbit with low fold below eye and projecting shield above pupil. Teeth small, numerous, in pavement-like formation. Nostrils oblique. Spiracles large, close to eye. Tail muscular, wide at base, with two dorsal fins, moderate to small caudal. Pectorals extend opposite gill openings, but not on snout.

Genus TRYGONORRHINA Muller and Henle.

Trygonorrhina Muller and Henle, 1938, p. 90. (Logotype, *T. fasciata* Muller and Henle).

TRYGONORRHINA MELALEUCA sp. nov.

Snout obtusely pointed, rather short, slightly longer than interorbital width. Skin velvety. A row of thirteen spinous tubercles on median line of back, between eyes and first dorsal fin. Two more between first and second dorsals. Two rows of four tubercles situated two on either side of median line, and in line with second and third median tubercles. No tubercles near eye as in *fasciata*. Pectoral disc slightly narrower than long, its length 360 mm. (2·5) in the total length, 890 mm. Width of disc 338 (2·6) in the total length. Length of eye 23 (3·0) in interorbital width, 69.

Preocular length 92, slightly longer than preoral length, 90. Mouth large, transverse, its width 72 (1·25) in preoral length. Teeth small, surfaces smooth

and flattened, arranged in broad bands in upper and lower jaws. Width of internasal valve 78, its margin entire. Length of spiracle equal to that of eye, projecting forward below to middle of eye. Tail length 490, much longer than body. Width of tail at posterior insertion of ventrals equal to that of internasal valve. Ventral fins entirely separate, length 150. Claspers longer than ventral fins, length 180. First dorsal fin, height 70, longer than second dorsal, height 65. Distance of first dorsal from origin of tail 105 (8·5) in total length. Distance of second dorsal from origin of tail 245 (3·6) in total length. Last gill opening only slightly behind middle of pectoral disc.

Fig. 1. *Trygonohhrina melaleuca*, holotype male from Kingscote, Kangaroo Island.

Colour. Outer margin of disc off-white. A diffuse bluish-black pattern covering all of back and upper part of tail to caudal fin. Dorsal and caudal fins off-white. Four dark grey bars at posterior end of disc, two on either side of median line, in same position as bars on *fasciata.* Claspers with a black spot on distal ends. Lower surface of body white.

Described from a male specimen measuring 890 mm. total length, taken March, 1953, at Kingscote, Kangaroo Island, by Mr. E. Sundberg, of Kingscote. Type in South Australian Museum, Reg. No. F2769.

Differs from *T. fasciata guanerius* (Whitley, 1932), the South Australian subspecies, in the colouring and pattern, absence of tubercles near the eye, smaller number of tubercles in the median line, and in general body proportions, the tail being much longer in relation to the body in *melaleuca.*

TRYGONORRHINA FASCIATA GUANERIUS Whitley.

Trygonorrhina fasciata guanerius Whitley, 1932, p. 327.

Snout obtusely pointed, short, longer than interorbital width. A row of seventeen spinous tubercles on median line of back, between eyes and first dorsal fin. Two more between first and second dorsals. Two rows of four tubercles situated on either side of median line as in *melaleuca*. Pectoral disc broader than long, its width 374 mm. (2·3) in the total length, 864 mm. Length of disc 357 (2·4) in the total length. Length of eye 24 (2·5) in interorbital width, 61.

Preocular length 93, shorter than preoral length, 100. Mouth large, its width 78 (1·3) in preoral length. Teeth very small, arranged in pavement-like formation in upper and lower jaws. Width of internasal valve 83, its margin entire. Length of spiracle equal to that of eye, projecting forward below to middle of eye. Tail length 434, slightly longer than the body. Width of tail at posterior insertion of the ventrals 74 mm. Ventral fins entirely separate, length 156 mm.

First dorsal fin, height 88, longer than second dorsal, height 77. Distance of first dorsal from origin of tail 66 (13·0) in total length. Distance of second dorsal from origin of tail 182 (4·7) in total length. Last gill opening slightly behind middle of pectoral disc.

Colour. Disc and tail brownish-grey. A number of grey bars edged with dark brown forming a characteristic pattern on the disc as in Waite's figure (Waite, 1923, p. 47). Under surface white.

Described from a female specimen measuring 864 mm. total length, taken February, 1954, in St. Vincent's Gulf, South Australia. Specimen registered F2843 at the South Australian Museum.

FAMILY CHIRONEMIDAE.

Genus THREPTERIUS Richardson.

Threpterius Richardson, 1850, p. 68 (Haplotype *T. maculosus* Richardson).

THREPTERIUS CHALCEUS sp. nov.

D. xv. 17-18. P. 14. A. iii. 7. V. i. 5. C. 15-16. L.l. 47-48. L. t. 6 : 13.

Length of head 54 mm. (3·3), greatest depth of body 47 (3·8), greatest width of body 27 (6·6) in the total length 177 mm. Snout 18 (3·0), eye 13 (4·1) in the head. Depth of caudal peduncle 14. Interorbital 9. Branchiostegal rays 6. Gill rakers 16. Body slightly depressed anteriorly, compressed posteriorly. Dorsal profile strongly convex behind eye, concave above eye. Eye

encroaches upon the dorsal profile. Mouth small, not extending back to the eye. Lips thickened. Teeth small and conical, in several rows in front of jaws, single row at sides. Vomer with a single row of similar teeth. Gill membranes united across isthmus. Gill rakers short and numerous, longest measuring 2·5 mm.

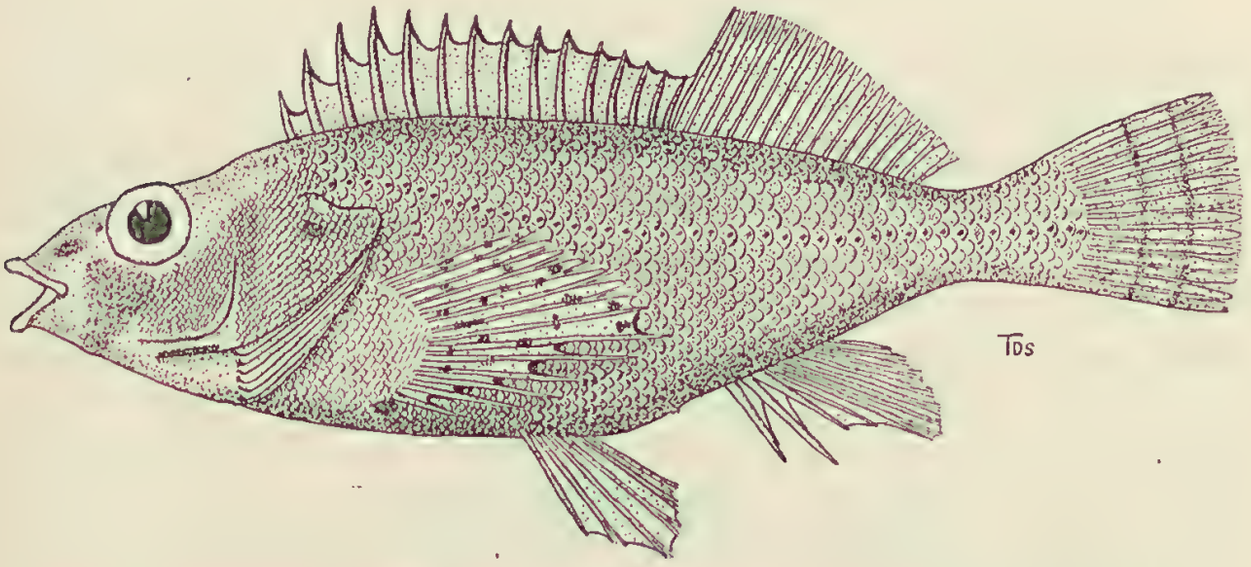

Fig. 2. *Threpterius chalceus*, holotype female from Kangaroo Island, South Australia.

Pectoral fin long, 9th ray being the longest, length 45 mm. Upper 7 rays of pectoral branched, and connected by a membrane. Lower 7 rays unbranched, the last four only joined at their bases. Dorsal fin begins above upper angle of operculum. Membrane of dorsal fin without scales. Ventral fins abdominal. Third spine of anal fin half as long as soft rays. Caudal fin rounded, length 25 mm. Scales small, preoperculum and operculum scaly, interorbital and snout scaleless.

Colour in Alcohol. Sides of body and upper parts of body dark brown. Head, operculum and ventral surface off-white with dark brown patches on the snout and under the eye. Dorsal and caudal fins off-white with dark brown bands. A small silver spot at the upper origin of the operculum.

In life, the sides and upper parts of body exhibit a bronze tint; the name *chalceus* is proposed, in allusion to the life colouration.

Similar in general appearance to *T. maculosus* Richardson, but differing in scale counts, number of dorsal spines, character of membrane of the spinous dorsal fin and the position of the silver spot on the operculum.

Described from a female specimen measuring 177 mm. total length, taken September 10th, 1952, on the West Coast of Kangaroo Island, South Australia. Presented by Mrs. I. M. Thomas of the Zoology Department, University of Adelaide. Type in South Australian Museum, Reg. No. F2729.

THREPTERIUS MACULOSUS Richardson.

Threpterius maculosus Richardson, 1850, p. 70, pl. ii, figs. 1-2.

Chironemus maculosus Gunther, 1860, p. 78.

D. xiv. 18-19. P. 14. A. iii. 8. V. i. 5. C. 16-17. L.l. 58-60. L. t. 11 : 22.

Length of head 81 mm. (4·0), greatest depth of body 70 (4·7), greatest width of body 40 (8·2) in the total length 327 mm. Snout 18 (4·5), eye 21 (3·8) in the head. Depth of caudal peduncle 24. Interorbital 13. Branchiostegal rays 6. Gill rakers 18.

Head depressed, body compressed. Dorsal profile strongly convex behind eye. Eye large, not encroaching upon the profile. Mouth large, extending back to below middle of eye. Teeth small, cardiform, arranged in several rows in front of jaws, single row at sides. Single row of similar teeth on the chevron-shaped vomer. Palatines and tongue toothless. Gill rakers short and numerous, longest measuring 4·5 mm. Base of pectoral fin scaly, scales extending on to part of fin. Operculum and subopercular scaly, several rows of scales on the preoperculum. Cheeks, snout and top of head without scales. Dorsal fin commences over upper angle of operculum. Seventh spine is the longest. Base of dorsal fin scaly. Spines of dorsal fin with a deep groove on each side. Caudal fin rounded, the rays projecting beyond the membrane. Anal fin commences opposite beginning of soft dorsal. Pectoral, anal, caudal, and soft dorsal fins with discontinuous black banding. Sides of body light brown, densely covered with dark brown spots. A silver spot on the hind edge of the operculum.

Described from a specimen measuring 327 mm. total length, taken February 18th, 1944, at Port Lincoln, South Australia. Registered number F2081 at the South Australian Museum.

FAMILY GOBIESOCIDAE.

KEY TO THE GOBIESOCIDAE OF SOUTH AUSTRALIA.

1. Dorsal fin not connected by a membrane with the base of the caudal fin 2
   Dorsal fin connected by a membrane with the base of the caudal fin ..... *Aspasmogaster tasmaniensis.*
2. Distance between termination of dorsal and base of caudal fin less than total base of caudal 3
   Distance between termination of dorsal and base of caudal fin greater than total base of caudal ..... *Parvicrepis parvipinnis.*
3. Dorsal fin with 8-9 rays. Upper surface without spots 4
   Dorsal fin with 6 rays. Upper surface densely spotted ..... *Cochleoceps spatula.*
4. Incisor teeth present in both jaws ..... *Volgiolus costatus.*
   Teeth in both jaws of uniform size ..... *Aspasmogaster patella* sp. nov.

Genus ASPASMOGASTER Waite.

Aspasmogaster Waite, 1907, p. 315 (Orthotype, *Crepidogaster tasmaniensis* Gunther).

ASPASMOGASTER PATELLA sp. nov.

D. 8-9. P. 18-19. A. 7-9. V. i. 4. C. 13-14.

Length of head 22 mm. (2·9), greatest depth of body 10 (6·4), greatest width of body 13 (4·9) in the total length, 64 mm. Snout 6 (3·6), eye 4 (5·5) in the head. Body depressed anteriorly, compressed posteriorly. Head rather broad, snout narrow, greatly depressed. Mouth small, extending back to below anterior third of eye, jaws equal. Teeth in upper and lower jaws villiform, in a single row. Eye moderately large, oval, encroaching slightly upon the dorsal profile. Dorsal profile strongly convex from beginning of head to tip of snout, slightly convex from above origin of pectoral fin to end of tail.

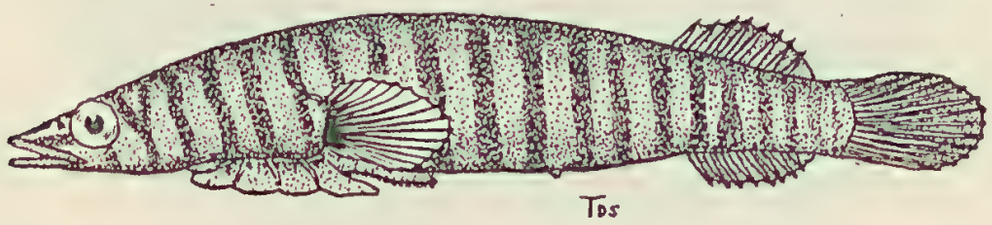

Fig. 3. *Aspasmogaster patella,* holotype from Kingston Park, South Australia.

Gill membranes united across isthmus at anterior origin of first adhesive disc. Pectoral fin short, length 8·2 in total body length. Pelvic fins attached to 17th pectoral ray. Dorsal fin small, height 16·1 in total length of body, base longer than base of anal fin. Dorsal begins more anteriorly than anal, but both are co-terminal. Caudal fin rounded, length 6·4 in total length. Anterior sucker slightly wider than body. Posterior margin of anterior sucker terminating at middle of posterior sucker. The posterior sucker does not overlap base of anterior sucker.

Posterior sucker oval, broader than long, width 5·8 in total body length. Vent mid-way between posterior margin of this sucker and origin of anal fin.

Colour in Alcohol. Yellow ochre, with twenty-one reddish-brown bars almost completely encircling the body. One of these bars crosses the snout, three bars pass from eye to eye, and the remaining seventeen bars, which are fairly uniform in thickness, lie between the eyes and the tail.

A single bar passes down either side of the snout from the tip of the upper jaw to the eye.

Aspasmogaster patella is closely allied to *A. tasmaniensis* (Gunther), but differs in possessing twenty-one cross-bars, compared with fourteen in the latter. The dorsal fin is not connected with the base of the caudal fin in *patella*, and body proportions differ considerably from *tasmaniensis*.

Described from a specimen measuring 64 mm. total length. Other specimens measuring 72, 56 and 57 mm. were collected with the type specimen in shallow pools at Kingston Park, South Australia, on September 26th, 1953, by biology students of the University of Adelaide. Type in South Australian Museum, Reg. No. F2788.

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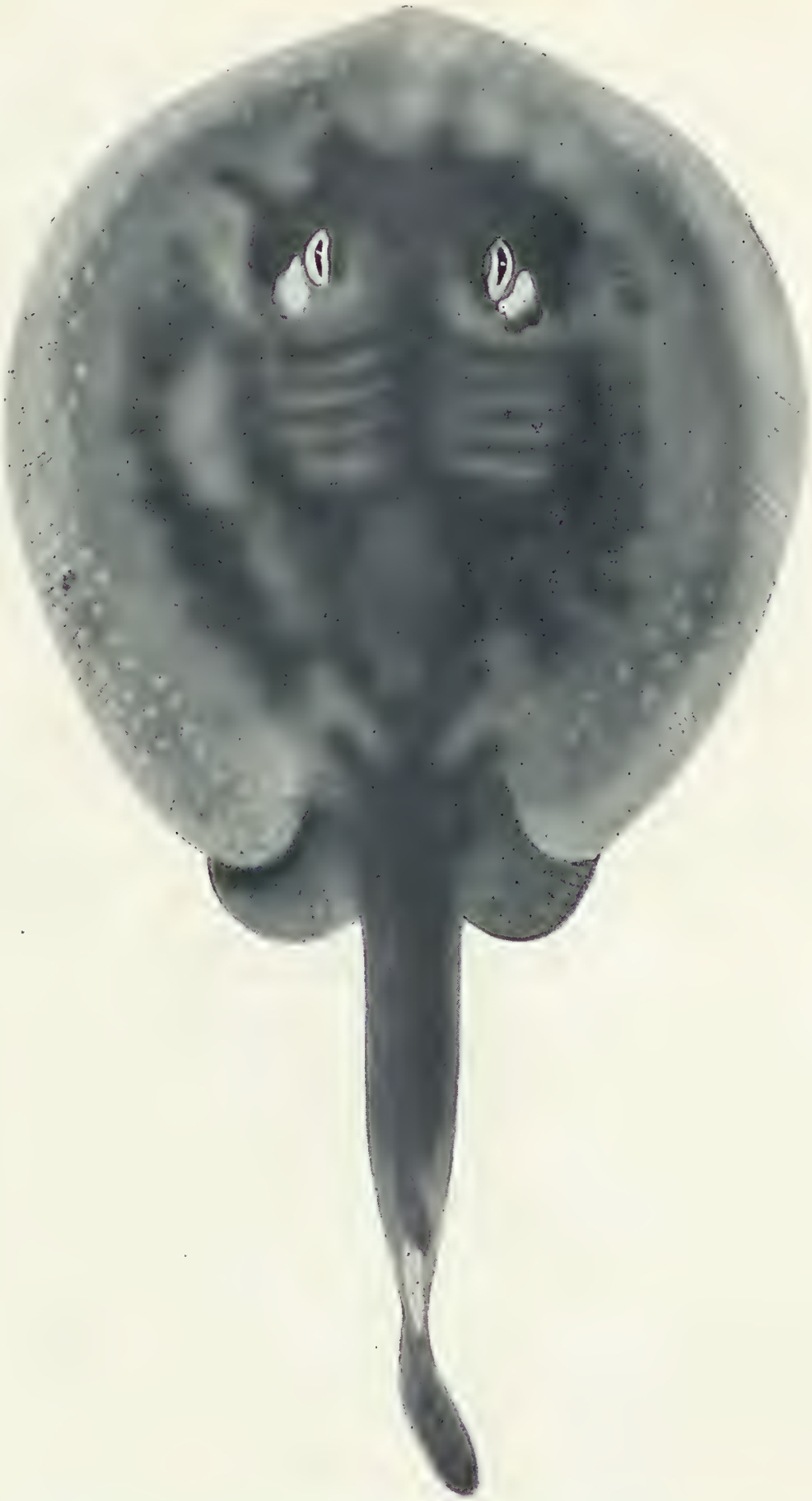

Urolophus gigas, holotype female from Port Noarlunga, South Australia.

TWO NEW SPECIES OF MITES (ACARINA: MESOSTIGMATA: ASCAIDAE) ASSOCIATED WITH BARK-BORING BEETLES FROM SOUTH AUSTRALIA

By H. WOMERSLEY, Entomologist, South Australian Museum.

Fig. 1-2.

Family ASCAIDAE Ouds. 1906.

Genus Dendrolaelaps Halbert 1915.

Clare Island Survey, Pt. 39 II Acarinida; Terrestrial and Marine, in Proc. Roy. Irish Acad., 31, 68-69, pl. 6, fig. 15 a-d.

Type *Dendrolaelaps oudemansi* sp. n.

Dendrolaelaps adelaideae sp. n.

Fig. 1 A-G.

As with the other known species of this genus, viz., *oudemansi* Halbert 1915, *armatus* (Kramer) 1886, and *quadrisetis* (Berlese) 1920, the following species are very small, white, and found amongst the frass of bark-boring beetles of the genus *Ips* and its allies.

Female. Length of idiosoma 325μ, greatest width on level of coxae II, 182μ. Shape, elongate with almost straight sides, and rounded anteriorly and posteriorly. Colour in life whitish. Dorsum divided into two by a line between coxae III and IV; on the anterior shield the setae are 14μ to 16μ long except a pair behind the 4 vertical, and one on each shoulder between coxae II and III which are 28μ long; on posterior shield the two longitudinal rows of setae are 14μ to 16μ long, the laterals from 25μ to 35μ; posteriorly with 3 pairs of longer setae, the anterior laterals 56μ long and of the two extreme pairs the inner pair 84μ, the outer pair to 100μ long. Venter: the sternal shield as figured, ending posteriorly at posterior point of coxae III; genital shield as figured, with straight posterior margin and 1 pair of setae; a pair of elliptical inguinal shields behind coxae IV; anal shield wider than long and narrower anteriorly than posteriorly, widely separated from genital shield. Legs shorter than body; I slender, 312μ long, II slightly thicker, 221μ long, without any specialized

armature; III 221μ long, IV 234μ long; coxae II narrow, and much broader than trochanter. Gnathosoma as figured, epistome (tectum) trispinous; chelicerae short and stumpy, movable finger with 4 prominent retrorse teeth; fixed finger with a strong subapical and subbasal tooth, and finely serrate in between.

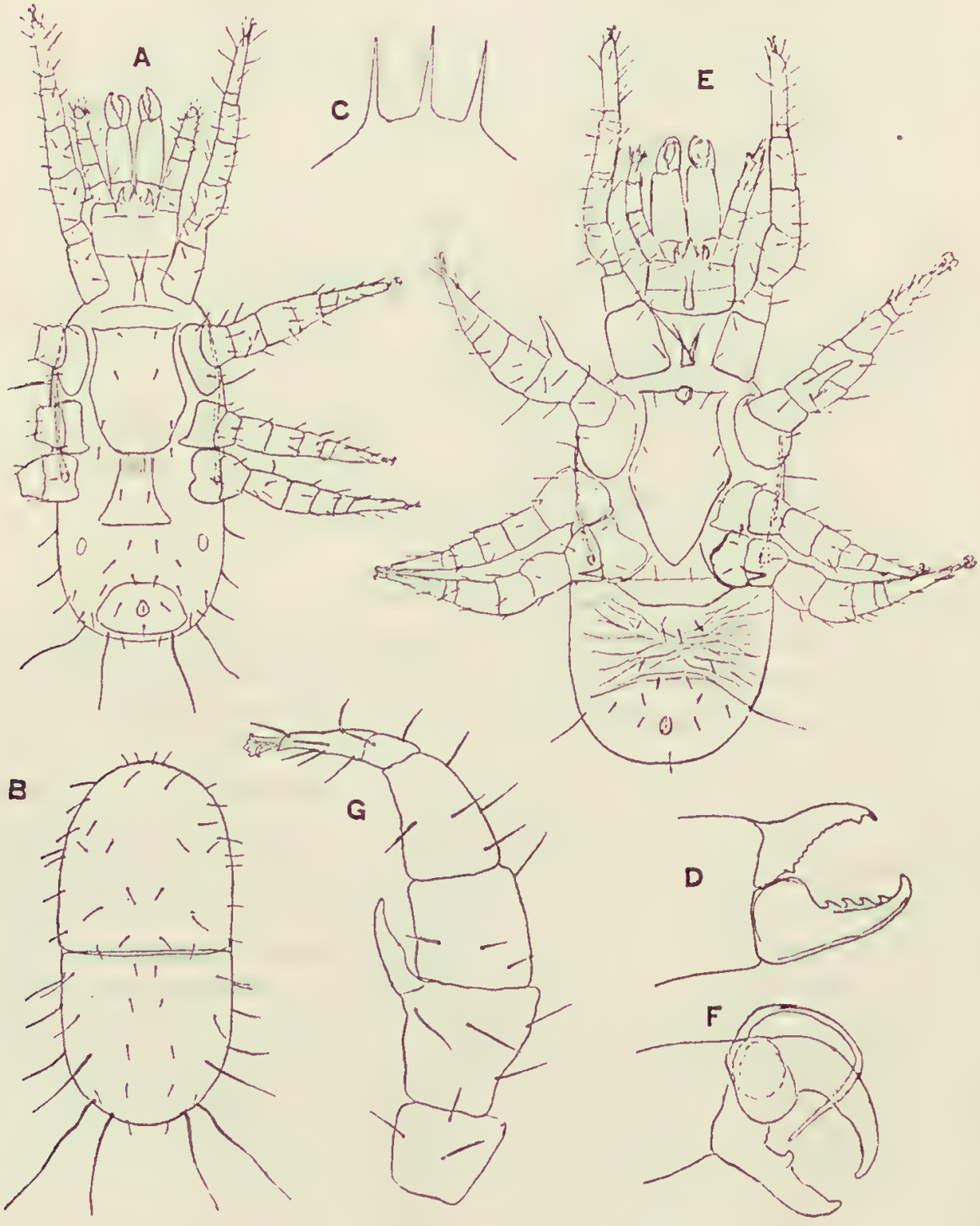

Fig. 1. *Dendrolaelaps adelaideae* sp. n. A-D, female: A venter, B dorsum, C tectum, D chelicerae; E-G, male: E venter, F chelicerae, G Leg II.

Male. Shape and colour as in female. Size from the material available larger than in female. Length of idiosoma 416μ, width 195μ. Dorsum as in female, with setae of similar lengths. Venter; sternal and genital shields as figured; anterior of anus is an indistinct transverse line which seems to suggest an incipient demarcation of an anal shield as figured, between this line and posterior of genital shield are some radiating lines. Legs: II much thicker than I and III, and IV also thicker, II armed on basifemur with a long and strong ventral spur, but no other incrassations, IV with a posterior spur on coxae; I 312μ long, II 269μ, III 221μ, IV 286μ. Gnathosoma as in female. Chelicerae as figured, fixed finger with a strong subbasal tooth; movable finger unarmed, with a long slender spermatophore carrier.

Remarks. This species differs markedly from the genotype *oudemansi,* in the shape of the anal or ventri-anal shield of the female, and the posterior margin of the sternal shield in the same sex. In the male, the second leg lacks the small incrassations or spurs on the other segments than the femur.

From the European *cornutus* the female differs in the shape of the ventrianal and inguinal shields, and the posterior end of the sternal shield. In the male, it lacks the small boss-like incrassations on the genu and tibia of leg II present in *cornutus,* and is different from both *oudemansi* and *cornutus* in having a spur on coxae IV.

Locality. The holotype ♀, and two paratype ♀ ♀ and the allotype ♂ from frass of bark-boring beetles, Adelaide, May, 1952. In the collection of the South Australian Museum.

DENDROLAELAPS CONCINNA sp. n.

Fig. 2 A-B.

Female. Shape as in preceding species. Colour in life whitish. Dorsum as figured, divided in two on level of coxae IV, anterior shield 195μ long, posterior 247μ; dorsal setae as figured, of similar lengths to preceding species. Venter: as figured; sternal shield ending between coxae III and IV with concave posterior margin, and the 3rd and 4th pairs of setae close together; genital shield as figured with 1 pair of setae; ventri-anal shield as shown, with irregularly scolloped anterior and lateral margins, widest in line of anus, with 6 setae in addition to anal setae, adanal setae longer, 31μ than post-anal 17μ; inguinal shields lenticular and longer than in *adelaideae,* all other ventral setae including sternal 14μ long. Legs: I longer and more slender than others, 351μ long, II 260μ, III 234μ, IV 300μ; tarsi with short ambulacra and paired claws. Epistome trispinous. Dentition of chelicerae not observable.

Locality. A single female from frass under bark infested with bark-boring beetles, Adelaide, May, 1951. In the collection of the South Australian Museum.

Remarks. Differs from preceding species in the shape and size of the ventri anal shield.

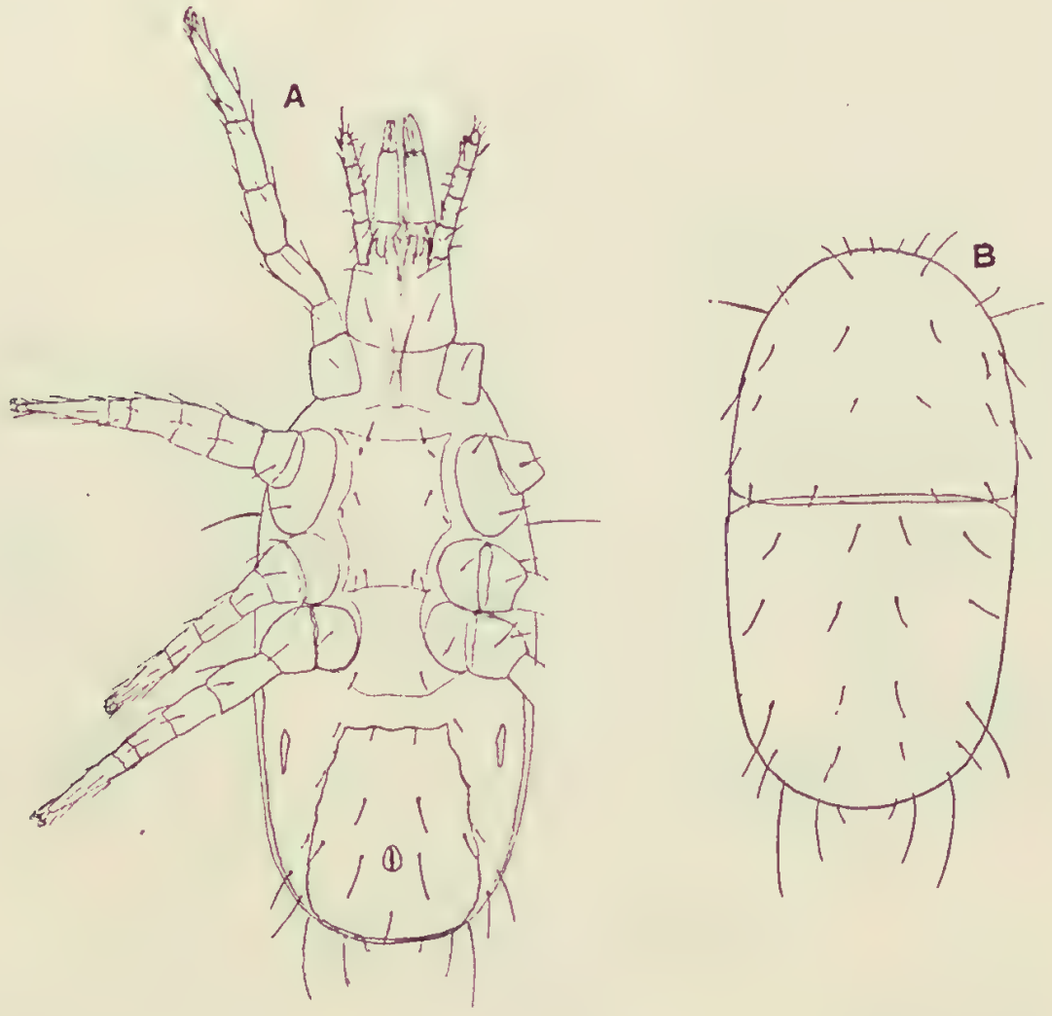

Fig. 2. *Dendrolaelaps concinna* sp. n. Female: A venter, B dorsum.

TWO NEW SPECIES OF ECTOPARASITIC MITES FROM POUCHED MICE, *SMINTHOPSIS* FROM AUSTRALIA

By H. WOMERSLEY, Entomologist, South Australian Museum.

Fig. 1-2.

Family LAELAPTIDAE Berlese 1892.

Laelaps (Laelaps) sminthopsis sp. n.

Fig. 1 A-D.

Description Female. Shape broadly oval. Dark brown and strongly chitinized. Length of idiosoma 1,300μ, width 845μ. Dorsal shield not entirely covering dorsum; as figured 880μ long by 500μ wide with numerous long slender setae to 120μ long; some of the anterior marginal setae on shield and anteriorly on the surrounding cuticle are rather shorter, stumpier and strongly shortly ciliated. Venter: tritosternum with base in front of margin of sternal shield; no pre-endopodal or jugular shields; sternal shield wider than long, with 3 pairs of setae and 2 pairs of pores, the anterior setae are short and ciliated, the others long and nude, surface reticulate; metasternal shields distinct with long slender seta and pore; genito-ventral shield small, flask-like but not conspicuously expanded behind coxae IV, with fimbriated anterior and 4 pairs of setae; metapodal shields small and round; cuticle behind coxae IV with numerous setae, lengthening posteriorly where they are more ciliated; anal shield rounded with usual 3 setae; setae on gnathosoma ciliated. Legs: rather short, II the thicker, I 780μ long, II 650μ, III 690μ, IV 975μ; coxae I with a very stout blunt smooth spur, a smaller one on II, the other setae on coxae ciliated and rather stumpy; legs with ciliated setae. Chelicerae small as figured, each finger with 2 subapical teeth and fixed finger with simple seta (pilus dentarius), pulvillum with spine-like teeth.

Male. Unknown.

Loc. and Host. The holotype female and 5 paratypes from *Sminthopsis leucopus* Gray, from Gorae, Victoria, 1937 (coll. H. H. Finlayson).

Remarks. In size this species is closely related to the genera *Macrolaelaps* Ewing 1929 and *Gigantolaelaps* Fonseca 1937. From the latter it differs

in having the normal 4 pairs of genito-ventral setae and the straight not medially produced anterior sternal margin. In *Macrolaelaps* the genito-ventral shield is much expanded behind coxae IV and almost reaches the anal shield.

Fig. 1. *Laelaps sminthopsis* sp. n. Female: A venter, B dorsum, C leg II, D chelicerae.

FAMILY LISTROPHORIDAE Canestrini 1892.

AUSTROCHIRUS SMINTHOPSIS sp. n.

Fig. 2, A-E.

Description. Form elongate, with dorsal and ventral semicircular scaling, not much compressed, but provided particularly on coxae II with a raised carina

for grasping hair, and the body posteriorly on coxae IV in life tending to incurve ventrally for the same purpose; legs I and II also slightly modified for grasping hair. Coxae in two comparatively narrowly separated groups. Dorsal shield trilobed. All tarsi with suckers. Legs IV of male stouter than in female, and in that sex with two pairs of anal suckers.

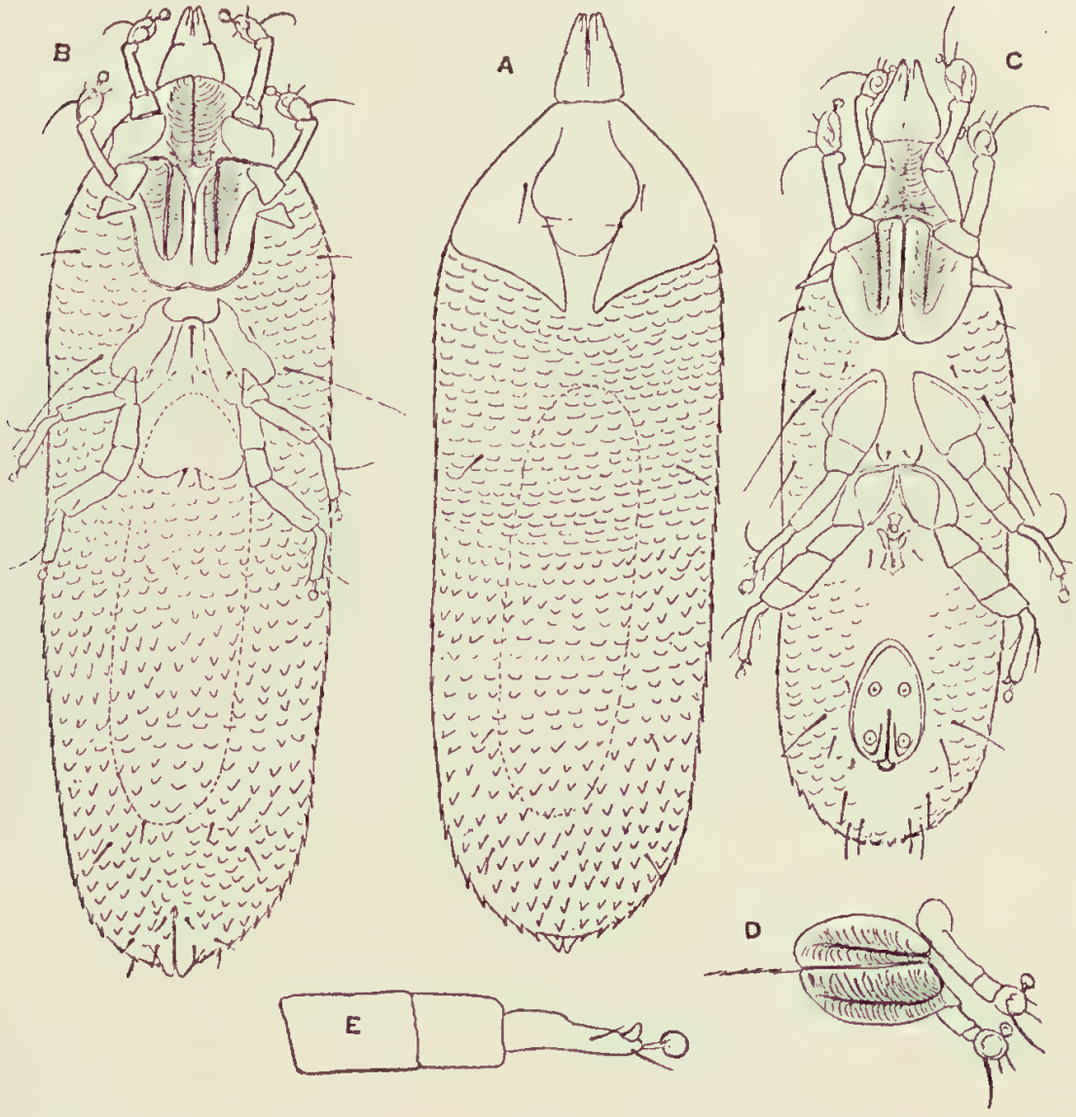

Fig. 2. *Austrochirus sminthopsis* sp. n. A, female dorsal view; B, same, ventral view; C, male, ventral view; D, coxae II and legs I and II in semilateral aspect to show raised carina; E, genu, tibia and tarsus of leg IV.

Female. Length of idiosoma to 377μ, width to 104μ. The dorsal shield about one-fifth of body length, divided into 3 lobes, the median of which is short and rounded, the laterals with the posterior margins curving inwards and bluntly pointed on inner angle; furnished with two pairs of setae, the anterior pair about 3 times as long as posterior; dorsum with 3 pairs of short setae.

Ventrally coxae I and II touching in the midline, that of II is enlarged with a strongly raised longitudinal ridge-like lamina, for grasping hair; posterior of coxae II on each side is a smaller triangular apparently movable sclerotized plate which may also assist in grasping hair, both coxae I and II apparently without setae; coxae III and IV also touching in median line, IV the larger, with setae as figured; the genital opening anteriorly between coxae III; on the cuticle between coxae II and III two pairs of long setae, the posterior lateral of coxae III the longest; on the posterior fifth of the venter are 4 pairs of short setae with 2 other pairs flanking the anal opening.

Male. Length of idiosoma 325μ, width 104μ, as in the female dorsally. Ventrally with the genital opening between coxae IV, the anal opening surrounded with an elliptical ring inside of which are two pairs of sucking discs. Leg IV with the trochanter femur and tibia much stouter than in female; apex of tarsi IV furnished with a strong subapical claw.

Loc. and Host. Numerous specimens from a specimen of *Sminthopsis crassicaudata,* the flat-tailed or yellow-footed pouched mouse from the Ninety-mile Desert, west of Tintinara, south-east of South Australia, September 27th, 1953 (coll. W. G. Heaslip).

Remarks. This species is placed in the genus *Austrochirus* Womersley, 1943, although in some respects, the more cylindrical form, the peculiar coxae II with the small accessory shield for grasping hair, the less modified legs I and II, the trilobed dorsal shield, and the strongly scaled cuticle, it does not quite conform to the genus as typified by *Austrochirus queenslandicus* Womersley 1943. Holotype ♀ and allotype ♂ and paratypes in the South Australian Museum collection.

On the SUBFAMILY *TROMBELLINAE* SIG THOR 1935 (ACARINA. TROMBIDIIDAE) with the DIAGNOSIS of the NYMPH of *AUDYANA THOMPSONI* WOMERSLEY, 1954

By H. WOMERSLEY, Entomologist, South Australian Museum.

Fig. 1-2.

The subfamily Trombellinae was erected in 1935 by Sig Thor (Zool. Anz. *109* (5, 6), 108) for the single genus *Trombella* Berl. 1887 (Acari. Myr. Scorp. Ital. rep., fasc. XL, No. 2) with *Trombella glandulosa* Berl. 1887 from Italy, as type. Included by Berlese in his 1912 monograph (Redia VIII, fasc. 1) were also the species *Trombella nothroides* Berl. 1888 (Acari Austro-americani, p. 10, tab. VI, fig. 2, and tab. VII, fig. 6 and 7) and *Trombella otiorum* Berl. (Riv. di Patol. Veget., IX, p. 127), the first from Brazil and Paraguay, and the second from Italy, Sardinia, Corsica and Norway.

In 1937 Womersley (Rec. S. Aust. Mus., VI (1), 75) also included in the subfamily the genera *Chyzeria* Canest. 1897 (Termes Fuzetek, *20,* 483) with *C. ornata* Canest., 1897, as type from New Guinea and represented by several species in Australia, and *Parachyzeria* Hirst 1926 (Proc. Zool. Soc. London, p. 825) with *P. indica* Hirst 1926 as type. (*Thaumatotrombium* André 1938 with *Th. poecilotrichum* André 1938 as type is synonymous with *Parachyzeria* Hirst).

This placing of *Chyzeria* and *Parachyzeria* in the Trombellinae has since been followed by other workers, Vitzthum, 1941, Baker and Wharton, 1952, etc.

The subfamily was defined by Sig Thor 1935 as follows:

> "Körper langgestreck. Abdomen rektangular. Haut hart, höckerig; Haare kurz und spitz. Crista fehlt; die 2 Sinneshaare sitzen dicht beisammen an der Mitte des Thorax in 2 dicken Tuberkeln zwischen den 2 ungestielten Doppelaugenpaaren. 4 Palpenglied mit verschiedenen Dornen oder Haaren; 5 Glied lang."

Vitzthum 1941, defines the subfamily rather more fully so as to include *Chyzeria* and *Parachyzeria,* thus:

> "Grosse scharlachrote, dunkelrote oder schwarze *Acari* von 1500 bis 4400 m.m. Länge Rumpf ziemlich langgestreckt; Hysterosoma rechteckig, in *Chyzeria* mit jederseits 5 dorsolateralen Zipfelformigen Aussackungen; an deren Stelle bei *Parachyzeria* in Wirbeln büschelartig zusammenged

rängte Behaarung. Integumen mitunter (*Trombella*) hart, hockerig. Keine Crista metopica. Auf der Mitte des Propodosoma zwei pseudostigmatische Organe mit Trichobothrien dicht aneinander gedrängt, zwischen zwei sehr kurz gestielten Doppelaugen. Palpitibia mit mehreren Dornen und Haaren. Palptarsus lang, mindestens bis an die Spitze der Tibialkralle reichend, Beine mässig lang.''

The species of *Chyzeria* and *Parachyzeria* differ markedly from all the species hitherto placed in *Trombella* in the comparatively simple nature of the dorsal setae which, in the species of *Trombella,* are characteristically in the form of short to long slightly curved nude to ciliated setae at the apices of more or less elongate papillae. Nude or simple setae are found in *otiorum* and *nothroides,* but in other species they are ciliate. Again *Chyzeria* and *Parachyzeria* in their peculiar body form, apart from the lack of a crista and the sensillae bases being more or less close together in the midline of the propodosoma, seem to have but a meagre relationship to *Trombella.* It is therefore proposed that, while retaining them in the Trombellinae, they should be placed in a new tribe, the Chyzerini nov. with *Chyzeria* Canestrini as the type.

Of the three species of *Trombella* described by Berlese, both *otiorum* and *nothroides* do not agree very well with the genotype, *T. glandulosa,* in the following points: firstly, the characteristic dorsal pits furnished with peripheral setae in *glandulosa* are absent in both *otiorum* and *nothroides*; secondly, the palpal tibia has no distinct pectine in *glandulosa* but only a secondary strong spine at the base of the claw.

For *otiorum* and *nothroides,* therefore, a new genus *Nothrotrombidium*[1] with *Trombella otiorum* Berl. as genotype is now proposed.

The two more recently described species of *Trombella* from Australia, namely, *warregensis* Hirst 1929 (Proc. Zool. Soc. London, p. 168) and *adelaideae* Wom. 1939 (Trans. Roy. Soc. S. Aust., 63 (2), 149), agree in the above features with *glandulosa* and belong therefore to *Trombella* s. str. They are redescribed and keyed later in this paper.

In a current paper (Malaysian Parasites, VIII—New Genera and Species of Apoloniinae (Leeuwenhoekiidae—Acarina) from the Asiatic-Pacific Region—Raffles Museum), the writer has described the larva of a new genus and species as *Audyana thompsoni* from larvae from a scorpion, *Heterometrus longimanus,* from Pahang, Malaya, 1948.

On the basis of larval characters this genus was placed in the subfamily Apoloniinae of the Leeuwenhoekiidae, but at the time it was pointed out that the

[1]The species *Trombella lundbladi* Willmann 1939 (Arkiv. f. Zool. 31A, No. 10; 15) from Madeira will come into *Nothrotrombidium.*

subfamily was rather a heterogeneous assemblage of genera, many of which, when the nymphs and adults are reared and correlated with the larvae, will have to be placed elsewhere.

While the above paper was in the press, Dr. R. J. Audy was successful in rearing the larvae of *Audyana thompsoni* through to the nymph, and has very kindly asked me to study these nymphs.

This study has shown that the genus *Audyana* is closely related to the other genera of the Trombellinae and must be placed therein and *not* in the Apoloniinae. *Audyana* differs from *Trombella* s. str. in the apparent absence of eyes, the sensillae bases being wide apart and situated on the posterior margin of a large propodosomal shield, and in that the dorsum, instead of having glandular depressions, has lateral and sublateral protuberances furnished with the characteristic *Trombella* type of setae.

Genus AUDYANA Womersley 1954.

Diagnosis. Nymph. Trombellinae with the dorsum furnished with lateral and sublateral tubercles bearing 2 to 12 small lightly-curved ciliated setae at the apices of rather long peduncles. Propodosoma apically with a large triangular shield rather deeply excavated anteriorly; without crista, but with two widely separated pseudostigmata on its posterior margin furnished with long nude sensillae. Eyes absent. Palpi with strong tibial claw, and two accessory spines at base of claw; no pectines. Only one pair of genital discs.

Larvae. With a single anterior dorsal scutum, with 2 AM, 2 AL and 2 PL setae of which AM and AL are short and claviform; no antero-median process, but with a wide anterior hyaline portion. Legs: I 7-, II and III 6-segmented; tarsi with only a single claw. Palpal tibia with two short straight claws; maxillae and femora with short claviform setae. Genotype *Audyana thompsoni* Womersley 1954 (larva).

AUDYANA THOMPSONI Womersley 1954.

Description. Nymph. Colour in life creamy pink. Shape as figured. Length 739μ, width across propodosoma 533μ. With suture between propodosoma and hysterosoma, the propodosoma with a large triangular shield, 227μ long by 227μ wide, the anterior end of which is fairly deeply excavated. Eyes apparently absent. Crista absent. Sensillae filamentous and nude. ca. 100μ long, and sensillae bases situated behind the posterior margin of the propodosomal shield and 130μ apart. Chelicerae not observed. Palpi as figured, tibia with a stout claw with two strong accessory spines as its base, no pectines on tibia, tarsus long and

clavate and just exceeding tip of tibial claw. Dorsum with two to three lateral rows of strong tubercles furnished with peculiar short curved ciliated setae on long peduncles, the number on each dorsal tubercle varying from two to twelve; there are similar tubercles on the sides of the propodosomal shield; the dorsal

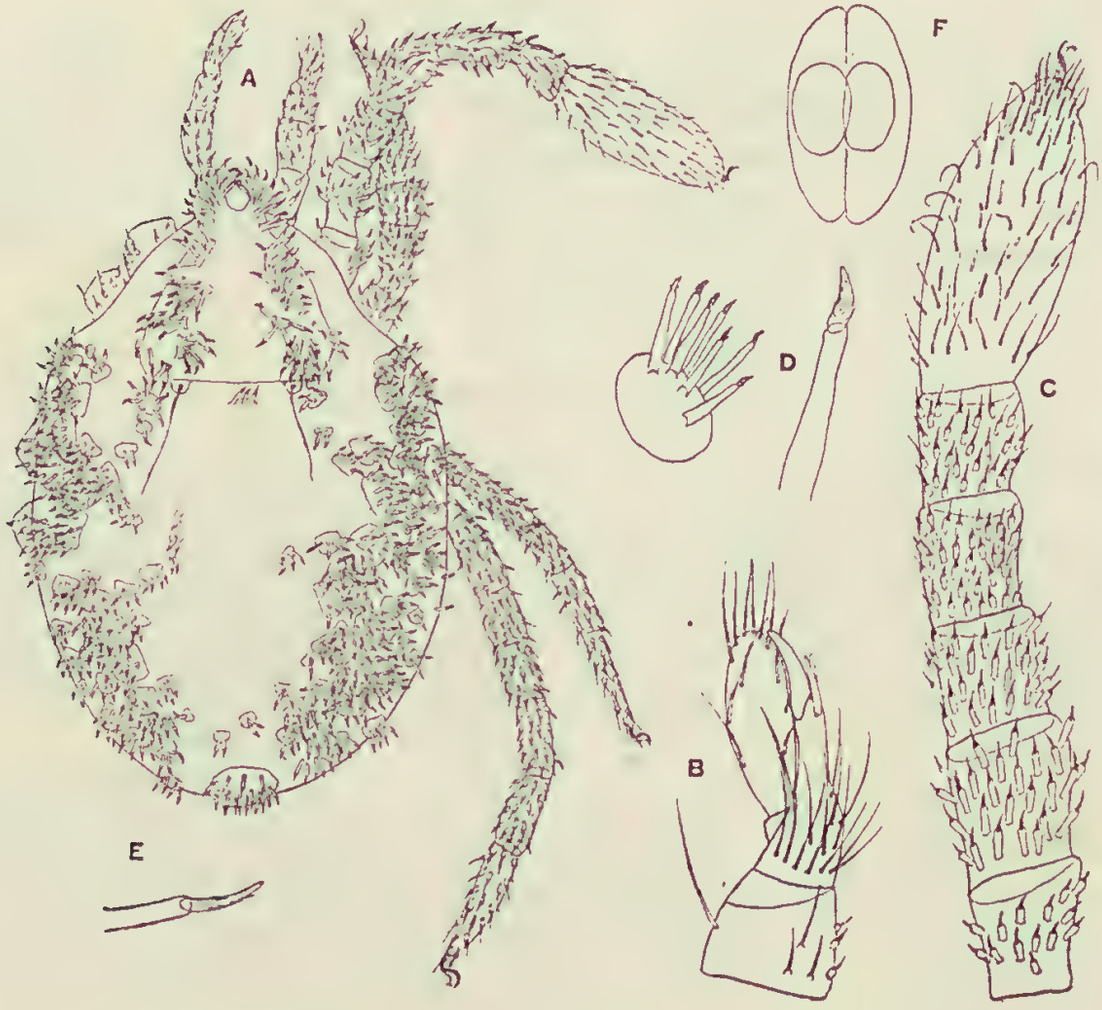

Fig. 1. *Audyana thompsoni* Wom. 1953. Nymph. A dorsal view, B palp, C leg I, D dorsal protuberance with one seta and peduncle more enlarged, E leg seta, F genitalia.

setae, plus peduncles, measure to 32μ. Legs: not longer than body, I as figured, 715μ long, II 559μ, III 559μ, IV 670μ; tarsus I 260μ long by 104μ high, tibia 84μ long; the setae on the leg segments, except the tarsus I, are of similar type to the dorsal setae but hardly ciliated and on rather shorter peduncles. The genitalia are as figured, with only a single pair of discs; 97μ long and discs 39μ long by 26μ wide.

KEY TO THE TRIBES AND GENERA OF TROMBELLINAE.

1. Large reddish acarids, with either dorso-lateral elongate processes on abdomen, and medially intermixed with the normal setae a number of fine filmentous sensillae-like setae; or without such processes, but with four large tufts of long fine setae arising anteriorly, and a few smaller tufts posteriorly. Crista absent, but senillae bases (pseudostigmata) close together with a pair of long filamentous sensillae. Eyes 2 + 2, sessile.
Tribe Chyzeriini nov. 2

Not as above, but of variable colour from red to black, without processes or bushes of setae on dorsum. With dorsal glandular pits or raised tubercles, or without these. Vestiture peculiar, consisting of short to rather long nude or ciliated, slightly curved setae at the apices of short to long peduncles. Crista absent, pseudostigmal organs widely separated.
Tribe Trombellini nov. 3

2. Dorsum with long lateral process and without bushes of setae.
Genus *Chyzeria* Canest. 1897.
Type *C. ornata* Canest. 1897.

Dorsum without processes but with strong bushes of long setae.
Genus *Parachyzeria* Hirst 1926.
Type *P. indica* Hirst 1926.

3. Dorsum with lateral and median circular glandular depressions, with more or less peripheral series of setae. Setae not on peduncles or only on short ones. Palpal tibia without a pectine. Eyes present 2 + 2, sessile.
Genus *Trombella* Berl. s. str.
Type *T. glandulosa* Berl. 1887.

Dorsum with lateral and sublateral protuberances furnished with peduncular setae, or without either protuberances or depressions 4

4. Dorsum with lateral and sublateral protuberances and setae on long peduncles. Eyes absent, no palpal pectine.
Genus *Audyana* Wom. 1954.
Type *A. thompsoni* Wom. 1954.

Dorsum without such protuberances, setae on only short peduncles. Palpal tibia with distinct pectine. Eyes present 2 + 2, sessile.
Genus *Nothrotrombidium* nov.
Type *T. otiorum* Berl. 1902.

Redescriptions of the two known Australian species of *Trombella* Berl. s. str.

TROMBELLA WARREGENSIS Hirst 1929.

Proc. Zool. Soc. 1929 (1), 168, fig. 5 K, L.

Fig. 2 A-D.

Length 1·84 mm., width 1·0 mm. Opisthosoma rectangular, with prominent squarish shoulders and rounded posterior; propodosoma subtriangular, 0·35 mm. long with a prominent nasus about 180μ long. Crista absent. Sensillae

missing but arising from raised denticulate papillae, 170μ apart, the denticles of papillae enlarging outwardly and ending in about four ciliated pointed setae arising from long peduncles. Eyes 2 + 2, small and lateral, and subsessile or shortly pedunculate. Palpal tibia with strong terminal claw and long accessory spine (or claw) basally of claw; tarsus large and clavate, over-reaching tip of claw; no pectines. Legs fairly thick, shorter than body, I 1,650μ long, II 1,125μ, III 1,125μ, IV 1,425μ, tarsi I 375μ long by 135μ, metatarsus I 300μ long. Dorsal

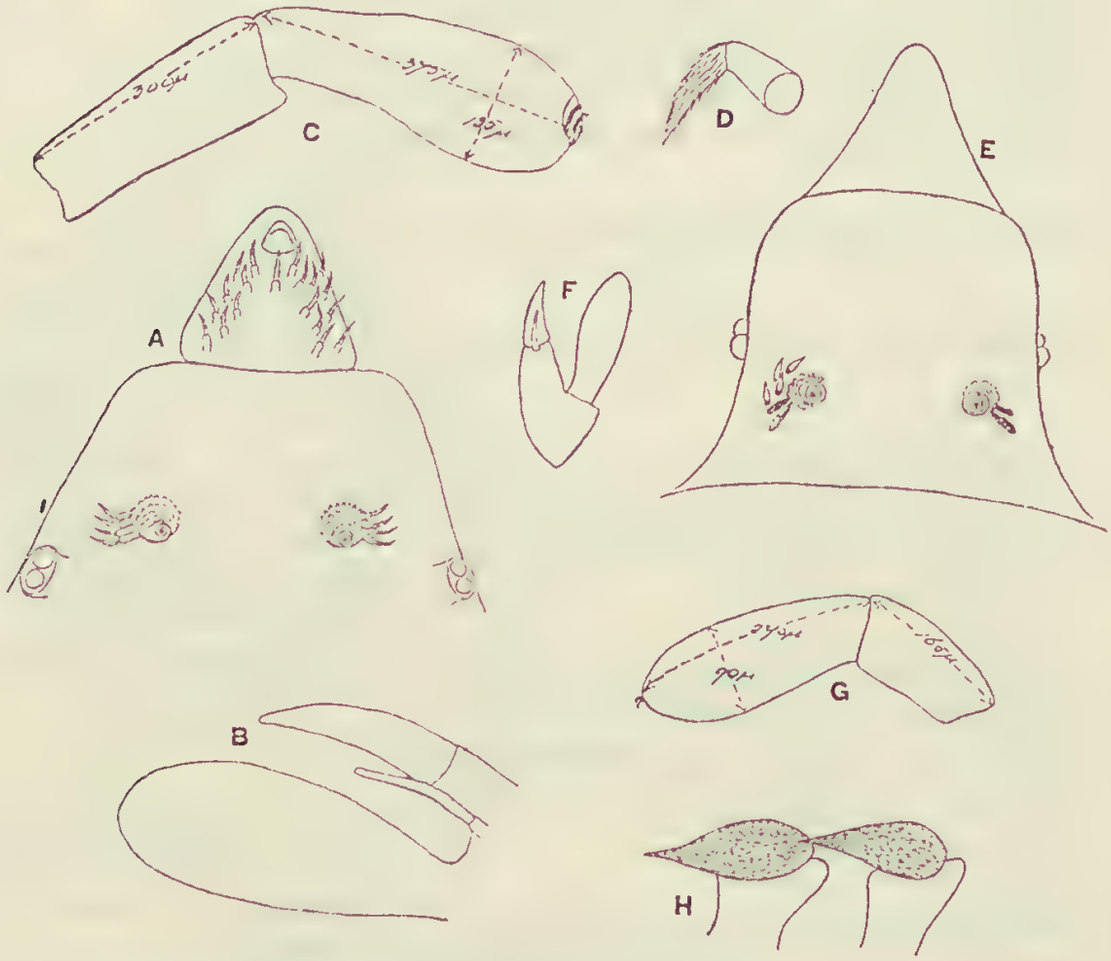

Fig. 2. A-D *Trombella warregensis* Hirst 1929. A propodosoma, B tarsus and tibial claw of palp (after Hirst, but now missing from type), C front tarsus and tibia, D one of the dorsal setae; E-H *Trombella adelaideae* Wom. 1939. E propodosoma, F palpal claw and tarsus, G front tarsus and tibia, H dorsal setae and peduncles.

setae decumbent conical, finely pointed with distinct ciliations, and arising from long upstanding peduncles, length of both peduncles and setae 29μ; similar setae occur on the nasus and the legs, and on the propodosoma anteriorly and laterally of the sensillae base, otherwise this portion is bare. The depressions on the dorsum consist of a row of 6 circular ones on each side, and medially with two circular ones followed by a large oval one and then a smaller circular one; all these depressions are ringed with setae of the usual shape but are

inwardly naked; the lateral rows all have strongly marked centres; ventrally behind coxae IV are 10 rather smaller depressions arranged 5 on each side. No genital discs.

Locality. The type, a single specimen from River Warrego, near Barringum, New South Wales, under a log, August, 1928 (S. Hirst), now in South Australian Museum.

Remarks. Hirst was unable to compare this specimen with *glandulosa* Berl. but from Berlese's figure, it differs in the size and dimensions of the front tarsi and metatarsi, the single simple curved accessory seta on the sensillae bases (see Berlese's fig. 3 and 8), and the ciliated and rather differently formed dorsal and leg setae; the dorsal depressions in *glandulosa* also have an inner ring or crown of setae.

TROMBELLA ADELAIDEAE Womersley 1939.

Trans. Roy. Soc. S. Aust., 63 (2), 149, fig. 1 A-D.

Fig. 2 E-H.

Length 1·2 mm., width 0·75 mm. Colour in life white. General form as in *warregensis* Hirst, propodosoma 225μ, with nasus 75μ long. Crista absent. Sensillae long and fine, arising from raised denticulate papillae bases, 126μ apart, the denticles enlarging outwardly and ending in one or two long, thick ciliated setae, different from the normal setae. Eyes 2 + 2, small, lateral and shortly pedunculate or subsessile. Palpal tibia as in fig. 2F, with strong terminal claw, and near its base with a strong spine (?accessory claw), no pectines; tarsus more or less clavate and over-reaching tip of claw. Legs fairly thick, shorter than body, I 1,050μ long, II 750μ, III 750μ, IV 960μ, tarsus I 270μ long by 90μ high, metatarsus 165μ long. Dorsal setae decumbent, conical, pointed, with, under high magnification, a very fine pubescence, and arising from upright long peduncles, length of setae 25μ; similar setae occur on nasus and legs, and anteriorly and laterally of the sensillae bases. Dorsal depressions 16, rounded, except the anterior one of medial row of four, which is oval, the lateral rows with six, all the pits are not ringed with a crown of setae, and the setae cover the whole pit-surface; ventrally behind coxae IV there appears to be only five small depressions. Genital discs absent.

Locality. A single specimen, the type, from under a stone, Burnside, South Australia, August, 1938 (J.S.W.).

Remarks. Closely related to *glandulosa* Berl. and *warregensis* Hirst, but differing in the arrangement of dorsal depressions, the dorsal setae, and the setae of sensillae bases.

KEY TO THE SPECIES OF TROMBELLA Berl. s. str.

1. The setae arranged in two peripheral rows on each depression. 2

   The setae on the depressions not in distinct peripheral rows. Tarsus I not parallel sided, half as long again as metatarsus (tibia) and about 3 times as long as high, widest at one-third from apex ..... *T. adelaideae* Wom. 1939.

2. Tarsus I with subparallel sides, slightly tapering to apex, twice as long as metatarsus and nearly 4 times as long as high ..... *T. glandulosa* Berl.

   Tarsus I not parallel sided, more or less clavate and widest beyond middle, less than half as long again as metatarsus and 2·75 times as long as high .... *T. warregensis* Hirst 1929.

SUMMARY.

The subfamily Trombellinae Sig. Thor 1935 is discussed and divided into two tribes, the Chyzerini nov. with the genera *Chyzeria* Canestrini 1897 and *Parachyzeria* Hirst 1926; and the Trombellini nov. for *Trombella* Berl. 1887 s. str. and allied genera.

The genus *Trombella* Berl. 1887 is separated into two groups, *Trombella* Berl. s. str. with *T. glandulosa* Berl. 1887 as type and *Nothrotrombidium* nov. with *T. otiorum* Berl. 1902 as the type. The latter genus also contains *T. nothroides* Berl. 1888; and *Trombella* s. str. the two Australian species *T. warregensis* Hirst 1929 and *T. adelaideae* Womersley 1939, both of which are redescribed.

The nymph of the larval species *Audyana thompsoni* Womersley 1954 is described from two specimens reared by Dr. J. R. Audy in Malaya, and the genus is shown to belong, not to the Apoloniinae (Leeuwenhoekiidae), as thought on larval characters, but the Trombidiidae.

Keys to tribes and genera of Trombellinae and to the species of *Trombella* s. str. are given.

A REVISION OF THE FLOWER BUGS (HETEROPTERA ANTHOCORIDAE) OF THE AUSTRALIAN AND ADJACENT PACIFIC REGIONS. PART I

By GORDON F. GROSS, Assistant Entomologist, South Australian Museum.

Fig. 1-4.

INTRODUCTION.

The Anthocoridae of this area now number at least 28 species, belonging to seventeen genera. Seven of the genera and twenty-five of the species are restricted to this region, the remainder are fairly cosmopolitan. A more detailed account of the ecology and Pacific zoogeography of this group appears at the end of the taxonomic account.

The usual differences in coloration, of apparent structure, and estimated dimensions that most past workers have employed to describe species in this family are, I am convinced, quite inadequate to separate very closely allied species or even to adequately characterize new species in some of the genera. I have, therefore, introduced as many measurements as practical into the descriptions and these when all else fails, or is strongly in doubt, will at least provide a concrete yardstick which can be relied upon, within the limits of observational error and normal variability, to be constant in the one species.

To do this it has been necessary to make permanent mounts in polyvinyl alcohol lactic acid medium. On the micrometer scale under the magnification used, each division was equivalent to approximately 17·24μ. Where measurements range from 200μ upwards, this gives relatively low deviations from 5 p.c. of the co-efficients of variation *per se,* but where the measurements range from 100μ downwards these large steps in relation to the value being measured usually induce larger deviations from this desired level.

Several measurements used are also subject to another kind of observational error irrespective of the relationship between the value of the measurement and the value of one division on the micrometer scale. This, in some cases, is due to difficulty in defining the edges or position from which certain measurements must be taken. An example would be across the anterior width of the scutellum,

which can depend on whether the animal is flexed, causing the pronotum to move forward (or backwards) over the scutellum, exposing more or less (depending on the flexure). In other cases this type of observational error is induced by obliqueness of the object measured (inevitable with such thick mounts), and this affects especially the legs, antennal and rostral segments. This error tends to lower the lower limit of the observed range and increase the standard deviation and co-efficient of variation.

All measurements are made with the aim to get the maximum length involved, and the usual ways in which this is effected is shown in fig. 4 E-I Only where there are more than five specimens has there been any attempt to treat the sample statistically, and then only in those measurements exceeding 100μ, in the other cases only the observed range is quoted.

The presence or absence of a well-developed ovipositor in the female, first systematically investigated by Myers and China, proves to be very useful on the generic level, and the shape of the male genitalia likewise is useful on both the generic and specific levels, these are both characters that have largely been neglected by past workers.

The family may be characterized as follows:

FAMILY ANTHOCORIDAE.

Head prolonged anteriorly, rostrum apparently three segmented, held away from the lower surface of head as in Reduviidae and Nabidae, antennae four segmented; a pair of ocelli present or absent; hemielytra with both cuneus and embolium separated by a distinct fracture. Tarsi three segment, no ariolia. Male genitalia strongly asymmetrical and ovipositor present, often reduced, or absent.

The three subfamilies are each represented here and may be distinguished by the following key.

KEY TO SUBFAMILY OF ANTHOCORIDAE.

Cell of hindwings with a hamus (spur into the cell), this is sometimes almost rudimentary 2

Cell of hindwings completely without a hamus ..... *Dufouriellinae.*

2. Last two antennal segments slender, filiform, with long hairs, hamus given off from the "vena connectens" or posterior transverse vein of cell ..... *Lyctocorinae.*

Last two antennal segments fusiform, short, without long hairs, hamus given off from the "vena subtensa" (interior longitudinal vein of cell) or rarely from the "vena connectens" ..... *Anthocorinae.*

Subfamily ANTHOCORINAE.

The most distinguishing feature is the short fusiform nature of the two terminal segments of the antennal and their short pilosity. This, however, does not apply to *Blaptostethus* Fieb. In addition, the hamus is usually given off from the "vena subtensa," but this is not so in *Maoricoris* China.

KEY TO AUSTRALIAN AND PACIFIC GENERA OF ANTHOCORINAE.

1. All femora unarmed 2
   Fore femora with denticles 4
2. Hamus arising from "vena connectens" as in Lyctocorinae, but with Anthocorine-like third and fourth antennal segments ..... *Maoricoris* China.
   Hamus arising from the "vena subtensa" 3
3. Apical annulation of the pronotum distinct ..... *Anthocoris* Fall.
   Apical annulation obscure or completely absent *Orius* Wolff (= *Triphleps* Fieb).
4. Last antennal segments fairly thick, spindle shaped. Whole body shining and smooth with very short hairs ..... *Lampronanella* Popp.
   Last antennal segments thin, filiform. Body longer, sparsely haired *Blaptostethus* Fieb.

Genus MAORICORIS China, 1933.

Maoricoris China, 1933, AMNH (10) 11, 514, fig.

Narrow, elongate, head exserted, with a distinct collum, antennae short, last two segments fusiform, rostrum just surpasses anterior coxae. Apical annulation of pronotum completely absent, lateral margins of pronotum straight, basal margin deeply excavate. Scutellum convex. Cuneus large, rounded at apex, membrane with four veins, middle two joining the interior to form two basal cells. Basal cell of wing with vein arising from the vena connectens, metapleural orifice produced anteriorly. Anterior femora inerassate, unarmed. Ovipositor absent or obsolete. Genotype *M. benefactor* China.

MAORICORIS BENEFACTOR China, 1933.

Maoricoris benefactor China *loc. cit.*, 516, fig.

Deep shining ferrugineous red, rostrum yellow, extreme base infuscate, antennae black. Hemielytra rather dull fuscous brown. An elongate spot down claval commissure, one half on the apex of each clavus and an indefinate round spot at apex of embolium extending onto corium, but not onto cuneus, pale

yellow. Coxae, bases and apices of femora sordid yellow, tibiae and tarsi pallid yellow.

Sparsely pilose, posterior margin of vertex behind ocelli with a characteristic fringe of backwardly-directed moderated short bristles. Relative lengths antennal segments 9: 21: 16: 16. Length, 2·8 mm. Maximum width of pronotum across humeral angles, 0·7 mm.

Loc. New Zealand.

Genus LAMPRONANNELLA Popp., 1909.

Lampronannella Poppius, 1909, Ac. Soc. Sci. Fenn., 37 (9), 39.

Elongate, shining, with very short prostrate hairs. Head hardly longer than wide. Rostrum surpasses the fore coxae. Antennae almost as long as the head and pronotum together, second segment as long as width of frons between eyes, and as long as the third and fourth together. Basal margin of the pronotum shallowly sinuate, apical annulation narrow but distinct. Disc posterior to the middle deeply transversely impressed. Orifice of the scent gland bent anteriorly. Middle coxae widely spaced, hind coxae approximated. Legs fairly short, fore femora incrassated apically and with two small teeth. Tibiae with very short teeth. Genotype: *L. reuteri* Popp.

This genus is very near *Orius* Wolff, but distinguished from it by the armed fore femora and tibiae. It is possible my *P. armatus* should be placed in this genus, but as this species differs only in the toothed fore tibiae from the remaining species of *Orius*, I prefer to describe it under that genus at this stage.

LAMPRONANNELLA REUTERI Popp., 1909.

Lampronannella reuteri Poppius, 1909, *loc. cit.*

Dark brown, the head lighter (reddish brown), hind femora and antennae brown, second antennal segment, rostrum, and legs yellow.

Antennae with short hairs. Basal width of pronotum about twice the medial length and much wider than fore margin, the disc is wholly flat, anterior lobe somewhat convex. Scutellum deeply impressed medially. Tibiae with very short thorns. Length, 1·8 mm.

Loc. New Guinea.

Genus BLAPTOSTETHUS Fieber, 1860.

Blaptostethus Fieber 1860, Wien ent. Monats., 4, 270; Reuter, 1885, Act. Soc. Sci. Fenn., 14, 611 and 666; Distant, 1910, Fauna British India (Rhynchota), 5, 309 (London).

Body elongate, shining, moderately pubescent. Head with a distinct collum. Rostrum long. Apical annulation of pronotum obsolete or very tenuous. Anterior femora somewhat incrassated, beneath in the middle with two obsolete tubercles and behind middle nearest the apex with two acute teeth, the first the larger. Terminal pair of antennal segments thin, filiform. Cell of the hindwings with a hamus arising from the "vena subtensa." Genotype: *B. piceus* Fieb.

BLAPTOSTETHUS PICEUS Fieber, 1860.

Blaptostethus piceus Fieber, 1860, *loc. cit.* 270, taf. 7, fig. 4; Reuter *loc. cit.* 667.

Body shining black, with a greyish pubescence. Hemielytra with a pallid punctuation on the interior apical angle of the embolium, the membrane also narrowly pale at its external basal angle. Head in front of the collum as wide (including eyes) as long. Pronotum anteriorly strongly transversely triate. Length, 3 mm.

Loc. Celebes, Sumatra, New Guinea and Lombok (*fide* Poppius, 1909).

Genus ANTHOCORIS Fallen, 1814.

Anthocoris Fallen, 1814, Spec. Nova Hemipt. Disp. Meth., 9; Van Duzee, 1917, Cat. Hem. Nth. Mexico, 292 (Berkeley, California), syn.

Body oblong, shortly pubescent above, sometimes almost glabrous. Eyes usually not touching pronotum but closely approximated to its anterior margin. Pronotum basally broadly emarginate with a distinct anterior collar. Rostrum reaching the anterior coxae. Orifice of the scent gland almost straight, or bent, but very slightly forward anteriorly. Posterior coxae almost contiguous, metasternum often produced between them in a simple lobe. Apex of the abdomen with long exserted setae. Female with a well developed ovipositor. Genotype: *A. nemorum* (Linn) = *sylvestris* (Linn).

There are two known species in these regions which can be separated by the following key. *Anthocoris arctatus* Walker, 1872, Cat. Heteroptera, 5, 153, is definitely not an *Anthocoris* for the long rostrum and third and fourth segments of the antennae distinguish it from this genus. It may be a *Cardiastethus*, but I have seem no examples of this genus which could fit Walker's description.

KEY TO AUSTRALIAN AND ADJACENT REGIONS SPECIES OF ANTHOCORIS.

Tegmina piceous, concolorous with body ..... *Anthocoris austropiceus* nov.

Tegmina cinereo-testaceous basally, apically and cuneus infuscated
Anthocoris pacificus Kirkaldy.

ANTHOCORIS PACIFICUS Kirkaldy, 1908.

Anthocoris pacificus Kirkaldy, 1908, Proc. Linn. Soc. N.S.W., 33, 374.

Piceous shining, almost glabrous. Second antennal segment and last segment of rostrum testaceous. Tegmina cinereotestaceous basally, apex and cuneus infuscate. Apex of anterior and middle femora, fore and middle tibiae and tarsi, and hind tarsi testaceous. Head almost as long as wide between eyes which are not nearly contiguous with pronotum. Second segment of antennae 2½ times as long as first and 1½ times as long as third, third segment slightly shorter than fourth. Lateral margins of pronotum subsinuate. Hemielytra shortly pilose. Fore femora with four or more bristles. Length, 2·76 to 3 mm.

Loc. Viti Levu, Fiji Island Group.

ANTHOCORIS AUSTROPICEUS sp. nov.

Fig. 1 A, B.

Body above wholly piceous, tibiae and tarsi only somewhat lighter.

Elongate, nearly glabrous, shining, with five or six prominent hairs on each side near the apex of the abdomen. Head with a distinct collum and the eyes consequently well removed from the anterior margin of the pronotum.

Pronotum with sides distinctly marginate into a narrow but explanate ledge, which continues almost straight right up to the anterior angles. Collar distinct, placed in front of the anterior angles.

Scutellum broadly and deeply transversely impressed near the middle. Hamus very distinct, arising from the vena subtensa.

The systematic measurements (which have been made on all the material available to me of this family) are for this species (in microns from one specimen):

Head. Total length, 362; length in front of eyes, 121; length behind eyes, 103; length of eyes, 155 : 172; width across eyes, 413; width of eyes, 86 : 86; interocular, 207; width of collum, 362.

Antennae. I, 121 × 52, 121 × 52; II, 293 × 52, 310 × 52; III, 207 × 34, 207 × 34; IV, missing, 207 × 34.

Rostrum. I, 155 × 69; II, 258 × 69; III, 207 × 69.

Pronotum. Anterior width, 396; posterior width, 809; median length, 258; lateral length, 465, 413.

Scutellum. Anterior width, 534; median length, 413; lateral length, 430, 430.

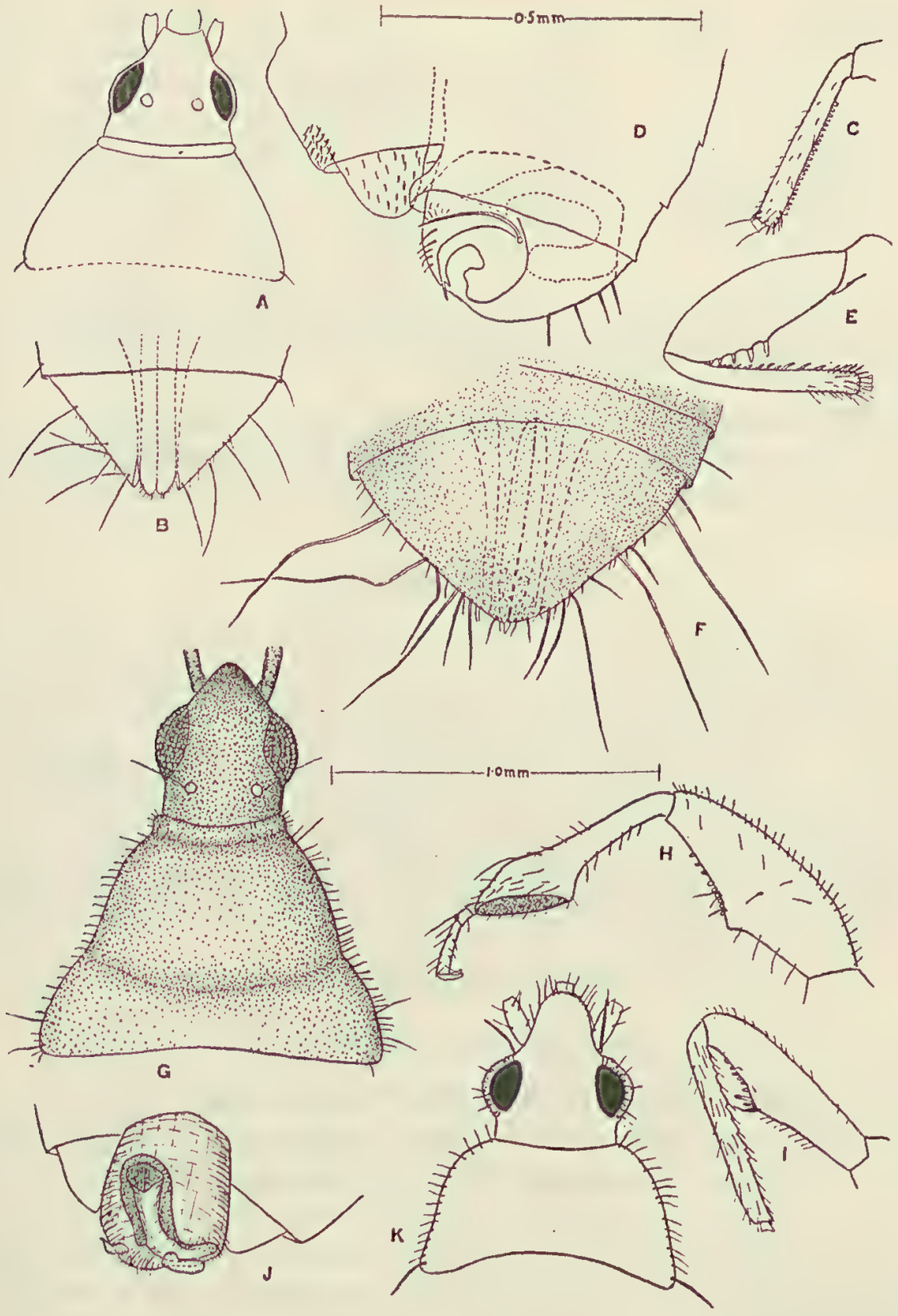

Fig. 1. A-B, *Anthrocoris austropiceus* sp. nov. Female. A, head and pronotum; B, apex of abdomen from above. C-D, *Orius armatus* sp. nov. Male. C, fore tibia; D, apex of abdomen from above. E-F, *Oplobates femoralis* Reut. Female. E, left front femur and tibia; F, apex of abdomen from above. G-I, *Falda queenslandica* sp. nov. Female. G, head and pronotum; H, left front leg; I, left middle leg. J, *Lyctocoris campestris* (Fab.). Male. J, apex of abdomen from above. K, *Lasiochilus derricki* sp. nov. Male. K, head and pronotum. (C-D, enlarged 80 diameters; A-B, E-K, enlarged 40 diameters.)

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	288	396	396	34	34	86	17
	275	430	396	not visible			
II	not clear	396	379	34	34	103	17
	not clear	396	396	34	52	86	
III	285	568	585	52	34	86	34
	not clear	637	585	52	34	?	?

Total length, 2,400; width, 880; length abdomen, 1,295; ovipositor, 637.

Loc. New South Wales: Bogan River (J. Armstrong, Holotype ♀ in Australian Museum).

Very closely allied to *A. pacificus* Kirkaldy in having the eyes remote from the anterior margin of the pronotum, but can be easily distinguished from that species by the concolorous hemielytra and the absence of spines on the fore femora.

Genus ORIUS Wolff, 1811.

Orius Wolff, 1811, Icon. Cim., 5, 4; Zimmerman, 1948, Insects of Hawaii 3, 176.

Triphleps Fieber, 1860, Wien Ent. Monat., 4, 266; references largely summarized by Van Duzee, 1917, Cat. Hem. Nth. Mexico, 293.

Body ovate or oblong ovate. Pronotal collar absent or very obsolete. Rostrum not surpassing fore coxae. Second segment of antennae as long or shorter than interocular. Ovipositor present. Genotype: *O. nigra* (Wolff).

There are two species in Australia, and they may be distinguished by the front tibiae being armed with small denticles in the case of *Orius armatus* sp. nov. and unarmed in *Orius australis* (China).

ORIUS AUSTRALIS (China), 1926.

Triphleps australis China, 1926, Bull. Ent. Res.. 17 (1), 361.

Elongate oval, almost glabrous. Black, hemielytra pale yellowish brown, with the clavus, embolium and cuneus more or less ferrugineous brown. Legs yellow.

The standard measurements in microns of the female specimen in the South Australian Museum are as follows (China's measurements, where given, follow in brackets):

Head. Total length, 360; length in front of eyes, 130; length behind eyes, 65; length of eyes, 160; width of eyes, 90-100; interocular, 170; width of collum, 400.

Antennae. I, 90-100 × 30 (93); II, 210 × 50 (203); III, 150-160 × 17 (156); IV, 160-180 × 40 (179).

Rostrum. I, 90; II, 250; III, 160.

Pronotum. Anterior width, 420; posterior width, 790 (690); median length, 273; lateral length, 400.

Scutellum. Anterior width, 530; median length, 390; lateral length, 420-440.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	270	390	350	40	70	70–80	40–50
II	220–230	390	340–350	30–40	70	80	40
III	260	460–480	530	50	90	80–90	40

Total length, 2,000; total length width hemielytra, 2,100 (1,750); total width, 790 (690); length abdomen, 1,020; length ovipositor, 570.

Loc. Queensland (no other data); 1 ♀ in S. Aust. Museum.

ORIUS ARMATUS sp. nov.

Fig. 1 C, D.

Fairly elongate. Head brownish black, pronotum and scutellum darker. Hemielytra yellowish. Legs ocelli and first two segments of antennae yellow, remaining two segments of antennae darker. Eyes reddish black.

Head with but a very short collum. Lateral margins of pronotum straight, marginate, anterior margin almost straight, hind margin almost concave. A punctate crescent in the hind fifth of the pronotum not reaching the edges, anterior portion of disc slightly raised. Scutellum almost planate, slightly raised anteriorly.

Fore tibiae with about 21-23 short denticles (approximately 6μ long). Male genitalia asymmetrical (fig. 1 D).

The standard measurements in microns of the type and paratype are:

Head. Total length, 310-350; length in front of eyes, 120-130; length behind eyes, 50-80; length of eyes (oblique), 140-170; width across eyes, 360; width of eyes, 80-90; interocular, 130-140; width of collum, 300-320.

Antennae. I, 90-100 × 30-40; II, 200-210 × 50; III, 170 × 40; IV, 200-210 × 40.

Rostrum. I, 70 × 30; II, 180 × 50; III, 170 × 30.

Pronotum. Anterior width, 330-350; posterior width, 640-720; median length, 270; lateral length, 360-390.

Scutellum. Anterior width, 520-530; median length, 340-400; lateral length, 360-460.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	120	330–380	310–360	40	50	70	30
II	170–180	330–360	320–360	40	50	70	30
III	200	420–440	480–510	40	50–70	90	30

Total length, 1,970·2,030; total width, 770-780.

Loc. Queensland: Stanthorpe (E. Sutton, August 7, 1928, Holotype ♂), Mt. Cootha (A. A. Girault, June, 1929, Paratype of unknown sex, apex of abdomen missing, both in Queensland Museum).

Subfamily LYCTOCORINAE.

Terminal pair of antennal segments long and thin, usually with long hairs. Cell in the hind wings with hamus (inwardly directed spur vein) always arising from the "vena connectens." (Also called "vena decurrens," the transverse vein making up the hind margin of the cell.)

Five genera are represented in these regions, one of them new, and they may be distinguished by the following key.

KEY TO AUSTRALIAN AND ADJACENT PACIFIC LYCTOCORINAE.

1. Pronotum with a very marked transverse constriction about 2/3 of the way back ..... *Falda* gen. nov.
   Pronotum not as above 2
2. Orifice of the scent gland on the metapleura bent backwards apically. Margins of pronotum and hemielytra ciliate ..... *Lasiochilus* Reut.
   Apex of orifice bent forwards 3
3. Sides of pronotum and hemielytra ciliate, anterior femora armed ..... *Oplobates* Reut.
   Sides of pronotum and hemielytra not unduly ciliate 4
4. Our species large, black, suboval ..... *Lyctocoris* Hahn.
   Our species smaller, more elongate, bicoloured, anterior femora incrassated ..... *Xylocoris* Dufour.

Genus OPLOBATES Reuter, 1895.

Oplobates Reuter, 1895, Ent. Mo. Mag. 31, 170.

Body oblong, shining with a long pubescence. Head with a short collar behind the eyes. Rostrum hardly surpassing the base of the head. Pronotum

with a very tenuous anterior collar, sides not marginate or sinuate. Membrane with four distinct veins. Anterior femora armed, underneath with thin spines their whole length. Female with a well developed ovipositor. Genotype: *O. femoralis* Reut.

OPLOBATES FEMORALIS Reuter, 1895.

Fig. I E, F.

O. femoralis Reuter, 1895, *loc. cit.*, 171.

Fuscous above with a long yellowish pubescence, head ferrugineous, antennae and legs testaceous, the first and third antennal segments and the apical part of the second fuscous. Anterior femora infuscated on the upper surface. Hemielytra with a pallid mark within the interior angle of the embolium. Head in front of the collar as long as broad. Pronotum longer than the head, sides straight but curved apically, disc obscurely transversely impressed near the middle. Posterior tibiae shortly spinose.

Length, 3¾ mm.

Loc. Victoria (*fide* Reuter). Northern Territory, Melville Island (W. D. Dodd, one female in S. Aust. Museum).

Genus FALDA gen. nov.

Elongate, linear. Head fairly short, broad, little produced and strongly declivous in front of the eyes with a distinct but not very long glabrous collum. Antennae about as long as head and pronotum together, terminal pair of segments filiform long, last segment curved. Rostrum very short, surpassing base of head but not attaining fore coxae. Pronotum with a tenuous anterior collar, strongly transversely impressed about 2/3 way back, this impression continuing right to the lateral margins and giving the pronotum the aspect of such Lygaeids as *Pamera*. Anterior angles of pronotum placed behind the collar, lateral margins diverge gradually, going from the anterior angles to the constriction then thereafter diverge considerably more to the posterior angles. This latter section of the lateral margins gradually curved. Hind margin of the pronotum very shallowly excavate, almost straight, anterior margin slightly concave.

Scutellum with a deep puncture about 2/3 way back on either side and a third centrally near the tip. Hemielytra with on the clavus 3 longitudinal rows of punctures, the two outer straight and extending the whole length, the inner curved and restricted to the apical half, and on the corium near the inner edge one row running from the base to as far as the apex of clavus. Inner margin of clavus markedly sinuate. Cell of hindwing apparently with a hamus.

Orifice of the scent gland T shaped, the upper transverse portion crossing the whole pleurite at a level lower than halfway up, the vertical section running forwards as well as downwards from this right to the base of the pleurite and forming a 45° angle with the head of the T.

Fore and middle femora inerassated, subtriangular, armed with short teeth from the middle to the apex on their inner margin, fore tibiae markedly expanded to at least twice the width of the rest in their basal third. Middle tibiae and hind femora and tibiae normal. Female with a short ovipositor, apex of abdomen with a few long hairs. Genotype *Falda queenslandica* sp. nov.

This is at once an extremely distinctive genus and one which is hard to place systematically. The unusual shaped pronotum for an Anthocorid is approached only remotely by *Septicius* Dist. and *Arnulphus* Dist., and more particularly *Eulasiocolpus* Champ. *Arnulphus,* however, belongs to an entirely different subfamily. The inerassation of the first and second pairs of femora as well as that of the fore tarsi is extremely distinctive, *Scoloposcelis* being the only other genus in this region with two pairs of femora expanded, but in its case it is the fore and posterior femora, and *Scoloposcelis* lacks a hamus.

FALDA QUEENSLANDICA sp. nov.

Fig. 1 G, H, I.

Head, pronotum and scutellum dark brown, head and pronotum shining, collum darker. Head in front of eyes, rostrum, antennae, legs (except the spines which are black) and a median and lateral stripe on abdomen beneath yellowish brown. Remainder of underside very dark brown including a broad stripe on either side of the abdomen, reaching back to the seventh visible segment and between the pale areas described. Hemielytra darkish brown, but with some yellowish lightenings. Membrane brown. Head, pronotum and scutellum sparsely pilose, hemielytra a little more densely so. Collum glabrous. Last two filiform segments of antennae with very short hairs.

The standard measurements in microns from two specimens are:

Head. Total length, 570-590; length in front of eyes, 120; length behind eyes, 190-260; length of eyes, 240; width of head across eyes, 460; width of eyes, 160; interocular, 120; width of collum, 380.

Antennae. I, 210-220 × 70; II, 400-480 × 50; III, 450-520 × 30; IV, 500-570 × 30.

Rostrum. I, 280-310; II, 260; III, 120-140.

Pronotum. Anterior width, 380-430; posterior width, 1,030-1,090; median length, 570-790; lateral length, 790-880.

Scutellum. Anterior width, 690-760; median length, 520-600; lateral length, 550-640.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	550	770–860	640–690	70–90	90	160	90
II	530	670–860	670–800	50–70	90–140	150–190	90
III	290–330	1050–1170	1100–1190	50–70	120–210	170–240	70–103

Total length, 3,900; length abdomen, 2,700; length ovipositor, 760.

Loc. Queensland: Cairns District (A. M. Lea, Holotype ♀, Reg. No. I 20082); Mt. Tambourine (A. M. Lea, "rotting leaves," one Paratype, sex unknown—apex of abdomen missing, Reg. No. I 20083; both in S. Aust. Museum).

Genus LYCTOCORIS Hahn, 1835.

Lyctocoris Hahn, 1835, Wanz, I., No. 3, 19. In addition to the references quoted by Van Duzee (1917, Cat. Hem. Nth. Mexico 288, Berkeley, California), there is Zimmerman, 1948, Insects of Hawaii, 3, 174 (Honolulu).

Nesidiocheilus Kirkaldy, 1902, in David Sharp's Fauna Hawaiiensis, 127.

Body oblong or oblong ovate, with a very slight low pubescence, pronotum and scutellum shining, hemielytra densely punctate. Anterior collar of pronotum tenuous or very indistinct, anterior coxae almost contiguous. Female with an ovipositor. Genotype (Logotype): *L. domesticus* Hahn = *campestris* (Fab.).

There is only one species so far known from these regions, the very widely spread *L. campestris* (Fab.).

LYCTOCORIS CAMPESTRIS (Fab.), 1794.

Fig. 1 J.

Acanthia campestris Fabricius 1794, Ent. Syst., 4, 14; *Lyctocoris campestris,* Lethierry et. Severin, 1896, Cat. Gen. Hem., 3, 327, and Van Duzee, 1917, Cat. Hem. Nth. Mexico, 288 (syn.).

Dark ferrugineous, second segment of the antennae (except the apex), legs and hemielytra testaceous. Rostrum reaching middle coxae. The standard measurements in microns of two British specimens, kindly loaned for this purpose by the British Museum, and three Australian specimens (male and 2 females), are as follows:

Head. Total length, 640-750; length in front of eyes, 240-340; length behind eyes, 170-190; length of eyes, 220-260; width across eyes, 540-620; width of eyes, 120-190; interocular, 250-290; width of collum, 430-540.

Antennae. I, 140-190 × 50-70; II, 520-590 × 50-70; III, 340-380 × 17-34; IV, 330-380 × 17-34.

Rostrum. I, 280-370; II, 580-680; III, 380-390.

Pronotum. Anterior width, 570-650 (?-740); posterior width, 1190-1400; median length, 520-590; lateral length, 410-720.

Scutellum. Anterior width, 720-1000; median length, 490-690; lateral length, 590-780.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	430–530	690–740	700–790	50–70	90–100	140–190	90
II	380–400	800–890	740–830	50–70	90–120	170–200	90
III	470–520	1000–1120	1200–1310	70–90	120–190	190–240	100–120

Total length, 3,800-4,600; width across abdomen, 1,620-1,800; length abdomen, 1,820-2,540; length ovipositor, 850-900; length male genital capsule, 480-530.

Loc. South Australia: Urrbrae (H. M. Cane, June, 1946, 7 specimens in C.S.I.R.O. Division of Entomology, Canberra). Tasmania: Hobart (A. M. Lea, 3 specimens, 2 reared from wood, in S. Aust. Museum). A.C.T.: Duntroon (Willis, March, 1951, 1 specimen in C.S.I.R.O. Division of Entomolgy, Canberra). New Zealand; Auckland (May, 1950, "biting man at night," in Woodward Collection).

Genus LASIOCHILUS Reuter, 1871.

Lasiochilus Reuter, 1871, Oefv. Vet. Akad. Forh., 562; in Van Duzee, 1917, Cat. Hem. Nth. Mexico, 289-90, and the useful account by Zimmerman, 1948, Insects of Hawaii, 3, 172, syn.

Body oblong with a longish pubescence. Head with a short collar behind the eyes, frons between the eyes usually with one or two distinct arcuate lines. Rostrum reaching middle coxae. Pronotum with a very tenuous collar. Orifice of the scent gland produced backward. Apex of the abdomen with long exerted hairs. Female with an ovipositor. Genotype: *L. pallidulus* Reut.

The six species now known from this region may be distinguished by the following key.

KEY TO AUSTRALIAN AND ADJACENT REGIONS SPECIES OF LASIOCHILUS.

1. Hemielytra punctate 2
   Hemielytra not punctate 3
2. (1) Tibiae with thornlike spines ..... *fruhstorferi* Popp.
   Pronotum longer than head
   Tibia with five long spines, head longer than pronotum ..... *derricki* nov.

3. (1) Fore femora armed .... *solemonensis* nov.
   Fore femora unarmed 4
4. (3) Abdomen very elongate in relation to width (1350 : 620) ..... *misimae* nov.
   Abdomen not unduly elongate in relation to width (1300-1500 : 900-1000) 5
5. (4) Apex of abdomen with about 4 long hairs, fore and hind femora incrassated .... *femoralis* nov.
   Apex of abdomen with but short hairs, fore and hind femora less incrassated .... *vitiensis* nov.

LASIOCHILUS FRUHSTORFERI Popp., 1909.

Lasiochilus (Dilasia) fruhstorferi Poppius, 1909, Ac. Soc. Sci. Fenn., 37 (9), 9.

Elongate, shining. Above with a golden pilosity. Blackish brown tibiae and tarsi yellowish. Membrane brownish-black with a small light stripe at the apex of the cuneus.

Head as long as wide across the eyes, in front of eyes as long as an eye. Rostrum not surpassing middle coxae, second segment about 2½ times as long as the first. Pronotum longer than head, posterior width hardly twice the median length. Hemielytra longer than the body, obscurely punctate on the cuneus. Legs with fine hairs, tibiae with thorns.

Length, 2·8 mm.

Loc. Lambok Is.

LASIOCHILUS DERRICKI sp. nov.

Fig. 1 K, 2 A.

Elongate oval, pilose. Dark brown, legs (except apical halves of femora), rostrum and terminal pair of antennal segments brownish yellow. Hemielytra yellowish with a very broad diffuse transverse band about the middle and one apically on the coriaceous parts.

Rostrum almost attains hind coxae. Eyes ciliate. Sides of pronotum very ciliate, with the characteristic long hair on each corner. Fore femora somewhat incrassate, fore tibiae sinuate.

Clavus, adjacent part of corium and extreme hind portion of pronotum strongly punctate. Hemielytra somewhat abbreviated, not reaching apex of abdomen.

The standard measurements from two specimens in microns are:

Head. Total length, 430; length in front of eyes, 170-210; length behind eyes, 70; length of eyes, 170; width across eyes, 470; width of eyes, 100-120; interocular, 210-241; width of collum, 360-380.

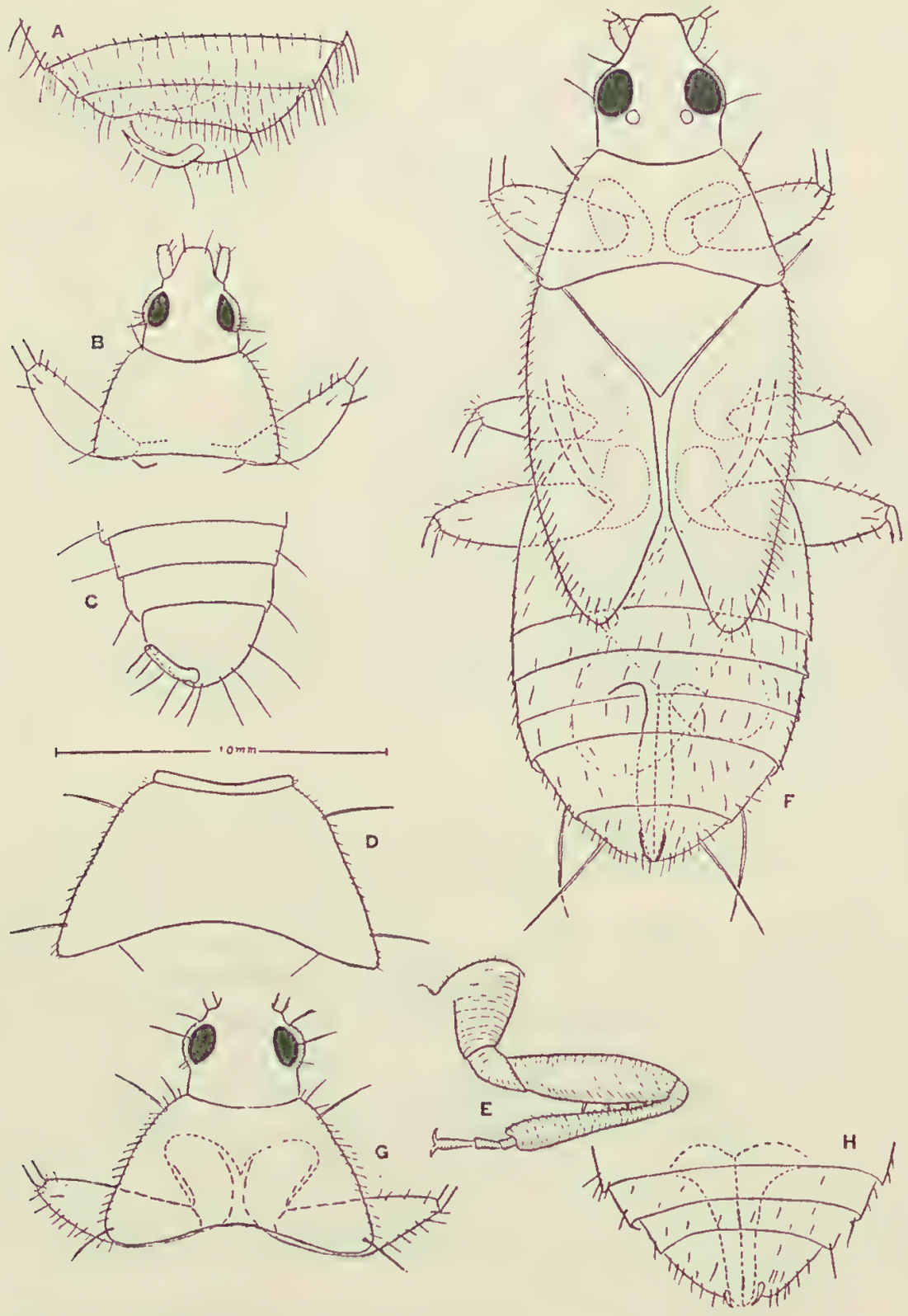

Fig. 2. A, *Lasiochilus derricki* sp. nov. Male. A, apex of abdomen from above. B-C, *Lasiochilus misimae* sp. nov. Male. B, head, pronotum and fore femora; C, apex of abdomen from above. D-E, *Lasiochilus solomonensis* sp. nov. Female. D, pronotum; E, right fore leg. F, *Lasiochilus femoralis* sp. nov. Female. F, dorsal outline. G-H, *Lasiochilus vitiensis* sp. nov. Female. G, head and pronotum; H, apex of abdomen from above. (All enlarged 40 diameters.)

Antennae. I, 120-140 × 50; II, 400 × 50; III, 360-380 × 30; IV, 410-430 × 30.

Rostrum. I, 260; II, 600; III, 400.

Pronotum. Anterior width, 600-640; posterior width, 790-860; median length, 400; lateral length, 480-500.

Scutellum. Anterior width, 520; median length, 430; lateral length, 450-470.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	not clear	520	570	50	90	140	70
II	240	570	550	50	90–100	140	70
III	260	690	790	70	90	160	70

Total length, 2,860-3,480; width, 1,090-1,240; length abdomen, 1,260-1,690; length male genitalia, 220; length female genitalia, 720.

Loc. Queensland: Brookfield (E. H. Derrick, 2nd Aug., 1949, "Berlesed soil litter," Holotype ♂, Reg. No. I 20071, Allotype ♀, Reg. No. I 20072, in S. Aust. Museum).

Seems to be very near *L. fruhstorferi* Poppius, but can be distinguished from this species by the different colouration, the shorter hemielytra, and the absence of thorns on the fore tibiae.

LASIOCHILUS MISIMAE sp. nov.

Fig. 2 B, C.

Very elongate, flattened. Castaneous, legs lighter almost yellow, femora between shades. Coriaceous parts of hemielytra and body with long sparse hairs. Eyes shortly ciliate, sides of hemielytra with short cilia, the usual long hairs at the four corners. Wings not attaining the tip of the abdomen, male genitalia very large with sparse long hairs. Fore femora very markedly incrassate.

The standard measurements (from one male), in microns, are:

Head. Total length, 360; length in front of eyes, 140; length behind eyes, 90; width across eyes, 310; width of eyes, 90; interocular, 140; width of collum, 290.

Antennae. I, 100 × 50; II, 220 × 30; rest missing.

Rostrum. 637 (individual segments are not clearly defined).

Pronotum. Anterior width, 360; posterior width, 570; median length, 310; lateral length, 360-380.

Scutellum. Anterior width, 400; median length, 260; lateral length, 290-310.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	240–260	210–230	290–330	34	52	90	34
II	190–210	310–350	310–330	34	52	90	34
III	210	450–470	470–480	34	86	189	34

Total length, 2,270; width, 620; length abdomen, 1,350; length male genitalia, 290.

Loc. New Guinea: Misima Is. (Rev. H. K. Bartlett, Holotype ♂, Reg. No. I 20073 in S. Aust. Museum).

This species does not seem to have any particular close allies in this genus; it can be distinguished from the other species here by the key characters.

LASIOCHILUS SOLOMONENSIS sp. nov.

Fig. 2 D, E.

Chocolate, antennae tibiae and tarsi yellow. Eyes grey, ocelli white. Hemielytra brown, membrane semi-opaque, light brownish. Elongate oval head with setae in front and behind eyes, pronotum with the usual hairs on the four corners, but with very short ciliations along the sides. Apex of the abdomen with a few sparse hairs. Rostrum not attaining fore coxae. Fore femora with four short teeth. Hemielytra surpassing the end of the abdomen.

The standard measurements (one female) are:

Head. Total length, 570; length in front of eyes, 170; length behind eyes, 170; length of eyes (oblique), 240; width across eyes, 470; width of eyes and interocular, not clear; width of collum, 400.

Antennae. I, 160 × 52; II, 360 × 70; III, 260 × 20-30; IV, 290 × 30.

Rostrum. I, 90; II, 550; III, 350.

Pronotum. Anterior width, 430; posterior width, 930; median length, 400; lateral length, 550-590.

Scutellum. Anterior width, 620; median length, 470; lateral length, 520.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	330	530–550	550–570	70	70	160	70
II	330	530–550	530	50–60	70–90	120	50
III	120–150	720–770	790–810	30	90	120–150	50–70

Total length, 3,100; width, 1,120; length abdomen, 1,590; length female genitalia, 670.

Loc. Solomon Is. (J. H. L. Waterhouse, "on bunches of dried bananas," Holotype ♀, Reg. No. I 20074, in S. Aust. Museum).

LASIOCHILUS FEMORALIS sp. nov.

Fig. 1 F.

Elongate, depressed. Castaneous, legs and antennae yellow. Head with a prominent hair behind and before each eye, and with a faint U-shaped mark between the eyes, the open end facing forwards. Eyes not ciliate, but with a long hair in front and behind. Pronotum with the usual long hair at each corner, but the lateral margins with very short hairs, disc very flat, hind margin almost straight. Sides of hemielytra prominently ciliate, hemielytra not surpassing the apex of the abdomen. Apex of abdomen with about 4 very long hairs, rest of body with but a very short pilosity including the terminal pair of antennal segments. Fore and hind femora markedly incrassated.

The standard measurements (in microns) for two females are:

Head. Total length, 410-460; length in front of eyes, 120-160; length behind eyes, 120-160; length of eyes (oblique), 140-160; width across eyes, 410; width of eyes, 100-120; interocular, 170-190; width of collum, 380.

Antennae. I, 120-150 × 50; II, 360-400 × 50-70; III, 260 × 20; IV, 240-260 × 30.

Rostrum. I, 140; II, 470; III, 260-290.

Pronotum. Anterior width taken as same as collum, fore angles shallowly curved; posterior width, 760; median length, 280-290; lateral length, 430-470.

Scutellum. Anterior width, 550-600; median length, 350-380; lateral length, 400-430.

Legs	coxa	femur	tibia	tibia I	II	III	Cl.
I	260	430–470	410–430	50	not clear in either spec.		
II	not clear	430–470	380	30	50–70	100	30–50
III	210–290	550–600	550–590	50	90	100	78

Total length, 2,550-2,800; width, 910; length abdomen, 1,290; length ovipositor, 570.

Loc. Queensland: Clermont (Dr. K. K. Spence, October, 1929, Holotype ♀ and one Paratype ♀, Reg. No. K62496 in the Australian Museum).

Seems to be fairly closely allied to the following species from which it can be distinguished by the long hairs at the apex of the abdomen, the more incrassate fore and hind femora, the much shorter hairs on the last two antennal segments, and the different colouration.

LASIOCHILUS VITIENSIS sp. nov.

Fig. 2 G, H.

Elongate oval, semi-depressed. Brown, a yellow fleck on the outer basal angles of the hemielytra, first two segments of antennae and femora brown, terminal pair of antennal segments, tibiae and tarsi yellow.

Head with a short hair behind each eye (there may be a short one also before each eye, but this point is not clear. Terminal pair of antennal segments with long hairs. Pronotum with the usual long hair at each of the four corners, sides with long ciliations, likewise the lateral margins of the hemielytra. Disc of pronotum fairly depressed with a low anterior callus behind which is a semi-circular depression. Apex of abdomen and remainder of body with mainly short hairs, fore femora fairly strongly incrassated.

The standard measurements (in microns) of two females are:

Head. Total length, 400-410; length in front of eyes, 160-170; length behind eyes, 90-100; length of eyes (oblique), 140-160; width across eyes, 400; width of eyes, 100-120; interocular, 160; width collum, 330-360.

Antennae. I, 120-140 × 50; II, 310-350 × 50; III, 280 × 20; IV, 200-280 × 20-30.

Rostrum. I, 90; II, 430; III, 220.

Pronotum. Anterior width taken as same as collum for the anterior angles are gradually rounded; posterior width, 790-810; median length, 330-360; lateral length, 450-480.

Scutellum. Anterior width, 620; median length, 410; lateral length, 470.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	260–310	470–480	360–410	50	70	100–120	40–50
II	240–260	430–470	450–480	50	70	120	50
III	280–310	590–600	690–710	50	100–120	120–140	70

Total length, 2,670-2,690; width, 980-1,000; length abdomen, 1,330-1,520; length ovipositor, 500-530.

Loc. Fiji Island Group: Viti Levu (A. M. Lea, Holotype ♀, Reg. No. I 20075, and one Paratype ♀, Reg. No. I 20076, in S. Aust. Museum).

Genus XYLOCORIS Dufour, 1831.

Xylocoris Dufour, 1831, Ann. Soc. Ent. France, 2, 106; Zimmerman, 1948, Insects of Hawaii, 2, 175; Van Duzee, 1917, Cat. Hem. Nth. Mexico, 290 (syn.).

Oblong ovate, shining. Eyes remote from the anterior margin of the pronotum, rostrum reaching middle coxae. Pronotal collar obsolete or tenuous. Apex of the abdomen (except in *flavipes* and *queenslandicus*) with a long pilosity. Anterior and posterior coxae contiguous, anterior and sometimes posterior femora somewhat incrassated. Anterior tibiae of the male apically strongly dilated. Our two species with prominent hairs on each of four angles of the pronotum; these are, however, very fragile (unlike *Lasiochilus*) and are easily broken off. Male genitalia very asymmetrical (fig. 3, A, C). Ovipositor present in the female. Genotype: *X. rufipennis* Dufour = *cursitans* (Fall.).

There are two species here, the widespread *X. flavipes* (Reuter) in its apparently typical habitat of stored grain, and a new species belonging to the *flavipes* group. This species (*X queenslandicus*) is larger than *X. flavipes* (2430-2780μ to *X. flavipes* 1500-2260μ), much darker as microscopic mounts, the female ovipositor is much longer in relation to the body than in *X. flavipes*. $\left(\frac{590\mu}{1{,}258\mu} \text{ to } \frac{260\mu}{1{,}070\text{-}1{,}090\mu}\right)$ and the male external genitalia are somewhat different (figs. 3 A, C).

XYLOCORIS FLAVIPES (Reuter).

Fig. 3 A, B.

Piezostethus flavipes Reuter, 1875, Bihang till S. V. A. K. Handl., 3 (1), 65; 1885, Acta. Soc. Sci., Fenn., 14; Puton, 1886, Cat. Hem. Pal., 43.

Elongate oval, piceous with a pale pubescence. Rostrum, antennae, legs and hemielytra yellow. Cuneus infuscated membrane fuliginous hyaline. Head pronotum and scutellum shining, almost glabrous. Dorsal surface of abdomen castaneous, ventral surface dark brownish to piceous. Eyes brown, ocelli red.

Pronotum somewhat convex, sides immarginate, anterior angles very slightly rounded. Scutellum anteriorly raised. Hind legs with some mediumly prominent spines. The standard measurements (in microns) of two females and one male are:

Head. Total length, 350-400; length in front of eyes, 140; length behind eyes, 90-100; length of eyes (oblique), 100-140; width across eyes, 350-360; width of eyes, 90-100; interocular, 170-190; width of collum, 330-360.

Antennae. I, 90-120 × 30-50; II, 220-260 × 40; III, 190-220 × 20; IV, 220-260 × 20.

Rostrum. I, 140?; II, 400? III, 410?.

Pronotum. Anterior width (fore angles too gradually curved to allow measurement); posterior width, 570-720; median length, 290-400; lateral length, 350-410.

Scutellum. Anterior width, 400-500; median length, 290-330; lateral length, 350-430.

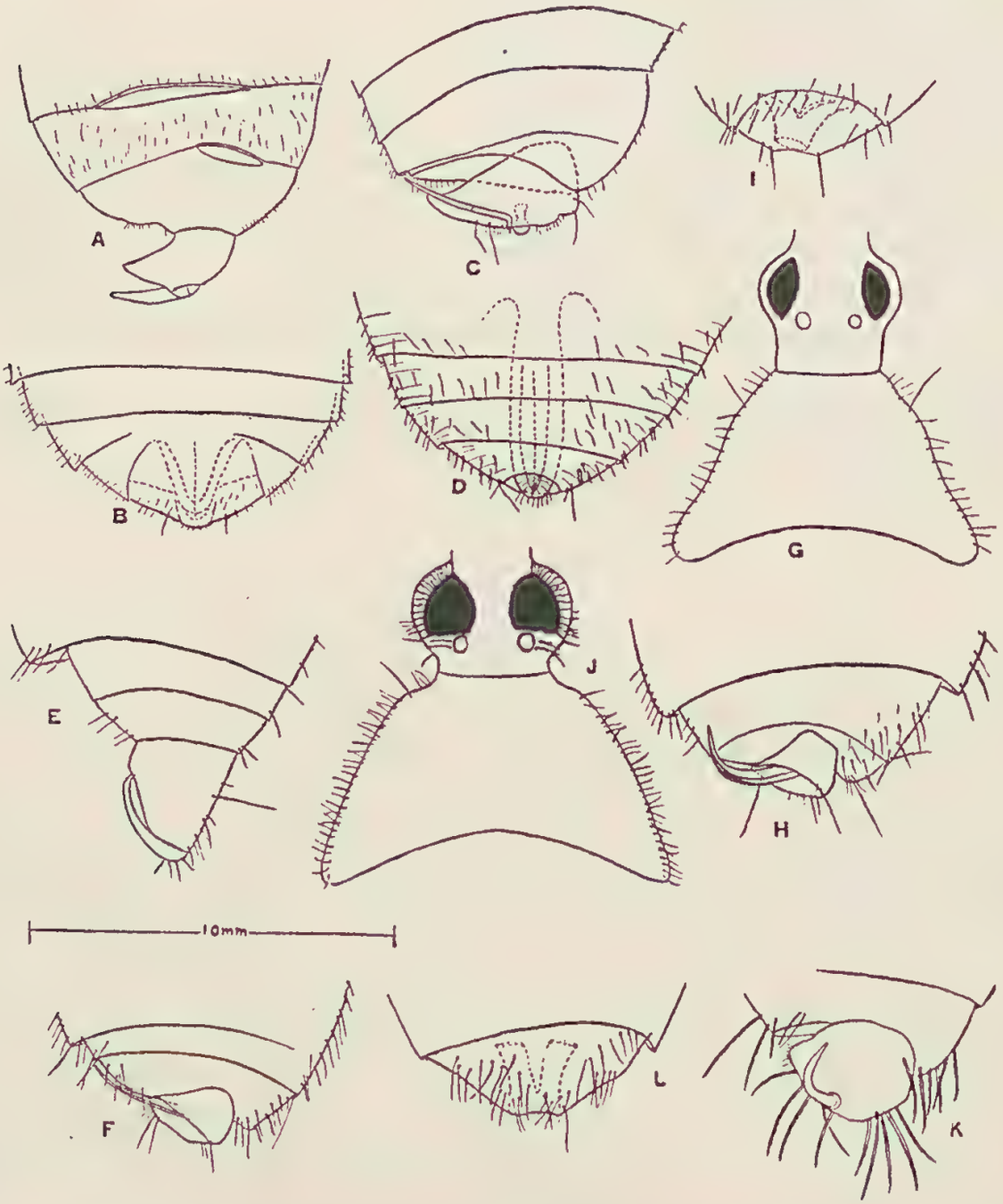

Fig. 3. A-B, *Xylocoris flavipes* (Reut.). A, apex of abdomen of male; B, apex of abdomen of female from above. C-D, *Xylocoris queenslandicus* sp. nov. C, apex of abdomen of male; D, apex of abdomen of female from above. E, *Plochiocorella elongata* Popp. Male. E, apex of abdomen from above. F, *Physopleurella mundula* (White). Male. F, apex of abdomen from above. G-I, *Physopleurella pacifica* sp. nov. Male. G, head and pronotum; H, apex of abdomen from above. Female. I, apex of abdomen from above. J-L, *Physopleurella armata* Popp. J, head and pronotum; K, apex of abdomen of male from above; L, apex of abdomen of female from above. (All enlarged 40 diameters.)

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	240–280	400–430	360–410	30	70	90–120	30
II	220–270	400–410	380–430	30–50	70	100	30–50
III	240–280	500–570	570–670	30–50	100–120	100–170	50

Total length, 1,500-2,260; width, 840-900; length abdomen, 1,070-1,170; length male genitalia (oblique), 380; length ovipositor, 260.

Loc. Fiji: Suva (R. A. Lever, 1st July, 1944, "Ex bagged rice," in Fiji Dept. Agriculture). Western Australia: Pintharuka (F. Wilson, August, 1941, "From insect-infested wheat," in C.S.I.R.O., Division of Entomology, Canberra). Has been recorded from similar locations overseas.

XYLOCORIS QUEENSLANDICUS sp. nov.

Fig. 3 C, D.

Elongate oval. Dark brown, eyes black, ocelli red. Hemielytra yellowish, membrane milky, cuneus infuscated. Rostrum, tibiae and tarsi yellow, antennae and other parts of legs yellowish brown.

Head and pronotum sparsely pilose, but hairs on head long. Hemielytra with a thicker golden pubescence, also the underside of the abdomen.

Pronotum flattened, immarginate, behind the middle with a suggestion of transverse striae, lateral margins straight and with but gradually rounded angles, anterior collar very tenuous. Scutellum slightly raised anteriorly. Fore coxae elongate, middle and hind tarsi with rather more prominent spines than *X. flavipes.*

Male genitalia directed to the left, ovipositor of the female longer in relation to the length of the abdomen than in *X. flavipes.* Apex of abdomen without long hairs, but a few rather short ones present.

The standard measurements (in microns) of four males and one female are:

Head. Total length, 400-430; length in front of eyes, 120-170; length behind eyes, 90-140; length of eyes (oblique), 160-170; width across eyes, 410-470; width of eyes, 90-120; interocular, 210-260; width of collum, 350-400.

Antennae. I, 100-140 × 50; II, 290-360 × 50; III, 260-280 × 20; IV, 260-310 × 25.

Rostrum. I, 170-240; II, 350-400; III, 200-260.

Pronotum. Anterior width, anterior angles too gradually curved to permit a measurement; posterior width, 830-950; median length, 360-430; lateral length, 510-590.

Scutellum. Anterior width, 590-740; median length, 450-500; lateral length, 500-600.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	380–450	500–570	450–570	30–50	70–90	120–160	70
II	290–360	480–600	430–570	30–70	90–100	120–160	70–80
III	290–380	560–720	670–880	30–70	100–140	170–190	70–80

Total length, 2,430-2,800; width, 910-1,140; length abdomen, 960-1,260; length male genitalia (oblique), 400-480; length female ovipositor, 590.

The individual measurements of the female tend to be 5-15 p.c. larger than those of the male, though not invariably, and this has contributed to the large observed range in some cases.

The differences in colouration and structure already mentioned distinguish this species from *flavipes.* From *X. discalis* (Van Duzee), the only other species in this region, of which I have only Abernathy's figure in Zimmerman's Insects of Hawaii (and which may not be a member of *flavipes* group as Abernathy's figure is no certain guide to whether the apex of the abdomen is with or without long hairs) *queenslandicus* seems to be distinguished by the lighter coloured antennae and fore tibiae.

Loc. Queensland: Cairns District (A. M. Lea, Holotype ♂, Reg. No. I 20077, Allotype ♀, Reg. No. I 20078, and three Paratypes, Reg. Nos. I 20079-81, in S. Aust. Museum).

Subfamily DUFOURIELLINAE.

Cell of hindwings without a hamus, second and third segments of antennae filiform, usually with a long pilosity.

This is our best represented subfamily, the two most characteristic genera being *Cardiastethus* and *Physopleurella,* both showing a marked reduction (or complete absence) of the ovipositor in the female.

The genera can be distinguished by the following key:

KEY TO AUSTRALIAN AND ADJACENT PACIFIC DUFOURIELLINAE.

1. Fore acetabula markedly intumescent, fore femora usually armed, fore tibiae bent ..... *Physopleurella* Reut.
   Fore acetabula not markedly intumescent 2
2. Fore femora interiorly armed 3
   Fore femora unarmed 4

3. Fore femora interiorly armed with bristle-like teeth, fore tibiae bent, body fairly thick set rounded, sparsely haired ..... *Orthosoleniopsis* Popp.
   Fore femora interiorly with more or less numerous stouter denticles, fore tibiae straight, hind femora also incrassated. Body slender, parallel sided, glabrous .... *Scoloposcelis* Fieb.
4. Basal margin of pronotum shallowly and broadly sinuate ... *Lasidiella* Reut.
   Basal margin of pronotum deeply sinuate 5
5. Orifice of scent gland on metapleura always bent forward and coalescing with the longitudinal keel in an arc reaching to, or nearly to, the anterior edge of the mesopleurae 6
   Orifice straight with apex more or less bent posteriad, the latter not coalescing with the longitudinal keel (where this is present) *Poronotellus* Kirk.
6. Antennae not very long, second segment not as long as head, our species fairly oval. Ovipositor absent .... *Cardiastethus* Fieb.
   Antennae very long, second segment longer than the length of head. A well-developed ovipositor present in the female ..... *Plochiocorella* Popp.

Genus LASIELLIDEA Reuter, 1895.

Lasiellidea Reuter, 1895. Ent. Mo. Mag., 31, 172.

Body elongate, parallel, flat, shining and smooth. Head about as long as wide with a short collum. Rostrum reaching middle coxae, first segment reaching the eyes, second the fore coxae. Pronotum depressed with a median longitudinal impression. Femora unarmed, embolium narrow. Genotype: *L. glaberrima* Reut.

LASIELLIDEA GLABERRIMA Reuter, 1895.

L. glaberrima Reuter, 1895, *loc. cit.*, 172.

Piceous, shining all over, rostrum apex of the femora base of the tibiae and tarsi, pale testaceous. Membrane fuliginous, interior basal angle paler. Scutellum depressed. Second segment of antennae $2\frac{1}{2}$ times as long as the first and as long as the head up to the hind margin of the eyes. Length, $2\frac{3}{4}$ mm.

Loc. Victoria (*fide* Reuter).

Genus PLOCHIOCORELLA Popp., 1909.

Plochiocorella Poppius, 1909. Ac. Soc. Sci. Fenn., 37 (9), 22.

Large, elongate, above conspicuously shining. Head and pronotum sparsely pilose, hemielytra more densely pilose. Rostrum surpassing fore coxae, antennae very long, noticeably longer than the head and pronotum together. Pronotum

and head about the same length. Lateral margins of scutellum serrate. Orifice of the scent gland anteriorly directed. Legs long, femora slightly incrassated and with longish hairs. Genotype: *P. elongata* Poppius.

There is, so far, only the one species in this genus.

PLOCHIOCORELLA ELONGATA Poppius, 1909.

Fig. 3 E.

Plochiocorella elongata Poppius *loc. cit.*, 23.

Dark brown, hemielytra largely yellow, a fairly broad transverse band across corium at about the level of the apex of clavus, the cuneus and a band along the inner margin of clavus brown, antennae brownish or yellow, legs and rostrum largely yellow, the body beneath is brownish black.

The standard measurements from three specimens (in microns) are:

Head. Total length, 600-640 (690 if first true rostral segment is included); length in front of eyes, 220-260 (330 if first true rostral segment is included); length behind eyes, 120-160; length of eyes, 210-220; width across eyes, 430-470; width of eyes, 120-160; interocular, 160-240; width of collum, 350-360.

Antennae. I, 160 × 70; II, 530-600 × 40-50; III, 510-520 × 20; IV, 370-470 × 20.

Rostrum. I, 160-210; II, 690-790; III, 290-330.

Pronotum. Anterior width, 330-400; posterior width, 930-950; median length, 400-430; lateral length, 600-670.

Scutellum. Anterior width, 500-640; median length, 500-570; lateral length, 500-570.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	240–310	640–800	740–790	50	70–120	120–140	50
II	220–290	740–790	740–810	50–70	100–120	140–160	50–70
III	200–260	880–950	1100–1170	50–90	160	140–170	50–70

Total length, 2,550-3,550; width, 1,030-1,090; length abdomen, 1,650-1,820; length male genitalia, 380-400; length female ovipositor, 770.

Loc. Queensland: Mt. Tambourine (A. M. Lea); Cairns District (A. M. Lea, both in S. Aust. Museum); Stanthorpe (E. Sutton, April, 1929, 3 males and 1 female, in Queensland Museum). New South Wales: Gosford (in S. Aust. Museum); Vaucluse (Dr. K. K. Spence); Deep Creek (Dr. K. K. Spence, February, 1932); Sydney (Dr. K. K. Spence, April, 1931, Reg. No. K64188, all in Australian Museum).

Genus SCOLOPOSCELIS Fieber.

Scoloposcelis Fieber, 1864, Wien. Ent. Monat., 7, 61; Van Duzee, 1917, Hem. Nth. of Mexico, 297 (Berkeley, California) (syn.); also Distant, 1906, Faun. Brit. India, 3, 6-7; 1910, *loc. cit.*, 5, 30; and Poppius, 1909, Ac. Soc. Sci. Fenn., 37 (9), 25.

Body elongate depressed, glabrous. Head in front of eyes broad. Rostrum surpassing the anterior coxae. Orifice of the scent gland curved forward, mesosternum flat, medially sulcate, acutely produced between the coxae at the base, apically truncate. Anterior and posterior femora flattened and incrassated, usually with spines or denticles along their length. Genotype: *S. crassipes* Flor. = *pulchellus* Zett.

There is only one recorded species from these regions and that is of remarkably widespread occurrence in the Indo-Australian region.

SCOLOPOSCELIS PARALLELUS (Motsch.), 1863.

Anthocoris parallelus Motschulsky, 1863, Bull. Soc. Mosc., 36 (3), 89.

Scoloposcelis parallelus Reuter, 1885, Act. Soc. Sci. Fenn., 14, 717; Distant, 1906, Faun. Brit. India, 3, 7; 1910, *loc. cit.*, 5, 304; Poppius, 1910, Wien. Ent. Zeit., 29, 140.

Scoloposcelis picicornis Poppius, 1909, Ac. Soc. Sci. Fenn., 37 (9), 26.

Glossy, piceous or dark brown, tibiae, tarsi and often the corium basally and near the claval suture yellowish brown. Head with some long hairs dorsally and laterally, fore and hind angles of the pronotum each with a long hair. Basal margin of pronotum very slightly excavate, about twice as wide as the median length and 1½ times as wide as the anterior margin. Fore femora with about four strong teeth, hind femora with more. Length, 2·5 mm.

Distributed from Ceylon to Queensland. One specimen apparently of this species (for it lacks the hind tibiae on which certain identification can be made) in S. Aust. Museum.

Genus ORTHOSOLENIOPSIS Popp., 1909.

Orthosoleniopsis Poppius, 1909, Ac. Soc. Sci. Fenn., 37 (9), 21.

Elongate, shining with a long erect dorsal pilosity. Head clearly longer than interocular, rostrum not attaining fore coxae, second segment not surpassing the base of the head. Base of margin pronotum deeply excavated. Fore acetabula simple, fore femora incrassated with short erect setae along the whole

of the anterior margin, fore tibiae weakly arched. Genotype, *O. australis* Popp.

Poppius compared this genus with *Cardiastethus,* but it is likely to be much more easily confused with *Physopleurella,* indeed it may be only a subgenus of this genus. It seems to be distinguished by not having the expanded fore acetabula of *Physopleurella,* in having a longer rostrum and a very broad interocular. The genotype is still the only species included.

ORTHOSOLENIOPSIS AUSTRALIS Popp., 1909.

Orthosoleniopsis australis Poppius, 1909, *loc. cit.,* 22.

Yellowish red. The legs yellow, the eyes, the apex of the second antennal segment, and the third antennal segment brown, the cuneus brownish red, pilosity yellow.

Head not longer than wide across the eyes. The second antennal segment clearly longer than these former. Posterior width of the pronotum about twice the median length. Posterior portion of the disc finely punctate. Hemielytra shining indistinctly punctured. Length, 3 mm.

Loc. New South Wales (*fide* Poppius).

Genus PHYSOPLEURELLA Reuter, 1885.

Physopleurella Reuter, 1885, Ac. Soc. Sci. Fenn., 14, 114 and 124.

Oblong, lateral margins of pronotum and embolium often with long backwardly directed cilia. Ocelli very large and prominent.

Rostrum short, thick, hardly (or not) surpassing the base of the head. Anterior collar of the pronotum distinct but tenuous. Fore acetabula markedly intumescent, anterior femora very incrassated, in our species armed with long spines along the inner margin, sometimes in several rows. Fore tibiae arched. Scutellum with lateral margins serrate. Genotype: *P. mundula* (White).

This genus is well represented in this region by at least five species. I have found the genus extremely difficult to treat for there is a great deal of uncertainty over the identity of the three species described here. *Physopleurella mundula* B. White has a conspicuous dark stripe down portion of the centre of the scutellum according to Zimmerman's figure, a Fijian specimen showing this character has, therefore, been relegated to that species. A series of specimens from N.S.W. and Queensland agree in many points with Poppius' *Ph. armata* and in other points with his *Ph. obscura,* showing amongst themselves quite a range of colour variation. I have, therefore, followed Usinger and regarded these two species as synonymous, and, as the firstnamed is first in Poppius' paper,

the species stands as *Ph. armata*. The remaining specimens fall into three new species.

These five species may be separated by the following key:

1. Apex of abdomen with long hairs 2
   Apex of abdomen with but very short hairs 4
2. Scutellum with a broad brown stripe running from the base to two-thirds way to apex, male genitalia in the form of an expanded, backwardly facing, cup with two very long sinistrally directed processes *mundula* B. White.
   Scutellum concolorous 3
3. Male genitalia composed of a large flat plate with a short process (fig. 3 K) hardly exceeding the limits of the plate. Sides of pronotum nearly straight, broadly rounded anteriorly *armata* Popp. = *Ph. obscura* Popp.
   Male genitalia composed of an expanded posteriorly directed cup from which emerge 2 long processes directed sinistrally *pacifica* nov. (fig. 3 H).
4. Lateral margins of pronotum almost straight, almost without hairs, broadly rounded anteriorly .... *bribiensis* nov.
   Lateral margins of pronotum sinuate, with long hairs in the anterior portion, anterior angles almost straight .... *australis* nov.

PHYSOPLEURELLA MUNDULA (White).

Fig. 3 F.

Cardiastethus mundula White 1877, A.M.N.H. (4), 20, 111.

Physopleurella mundula Reuter, 1885, Ac. Soc. Sci. Fenn., 14, 125; Usinger, 1946, Bernice P. Bishop Mus. Bull., 189, 55; Zimmerman, 1948, Insects of Hawaii, 3, 177, fig.

Pale rufous brown, with fairly dense long ochraceous pilosity, vertex of the head, first segment of antennae, the disc of the pronotum, a broad longitudinal stripe in the basal two-thirds of the scutellum, the cuneus, most of the underside of the body and femora darker. Collum very short, anterior margin of pronotum straight, posterior margin excavate, lateral margins sinuate and strongly ciliate, anterior angles very flat.

Orifice of scent gland directed anteriorly at apex, mesopleurae striate. Male genitalia in the form of an expanded backwardly-directed cup with 2 long thin sinistrally-directed processes, curving anteriorly at the tip. Apex of abdomen with long hairs.

The standard measurements (in microns) from one specimen are:

Head. Total length, 450; length in front of eyes, 140; length behind eyes, 90; length of an eye, 210-220; width across eyes, 410; width of an eye, 160; interocular, 100; width of collum, 280.

Antennae. I, 100 × 50; II, 360-380 × 50; III, 190-210 × 20; IV, 210 × 30.

Rostrum. 393.

Pronotum. Anterior width, 330; posterior width, 790; median length, 400; lateral length, 550.

Scutellum. Anterior width, 620; median length, 530; lateral length, 500-530.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	200–220	520–530	430–450	30	30	50	30
II	200–220	500–520	450	30	70	80–100	30
III	210–220	590–620	670	30–40	90	100–120	30

Total length, 2,500; width, 1,120; length abdomen, 860; length male genitalia, 240. White quotes the length as 2¾ mm.

Loc. Fiji: Moturiki (A. M. Lea, June, 1 male in S. Aus. Museum). Is apparently widespread over the Pacific, being recorded from Hawaii and Guam.

PHYSOPLEURELLA PACIFICA sp. nov.

Fig. 3 G-I.

Dark brown. Second, third and fourth segments of antennae, ocelli, apical portion of scutellum, rostrum, underside of embolium and tibiae and tarsi yellow. Eyes red to black, underside of abdomen (except centrally) infuscated. Pilosity golden, first segment of antennae, a transverse patch on hind margin of pronotum yellowish brown. Cuneus with a reddish tinge.

Collum distinct, glabrous. Anterior margin of pronotum straight, posterior margin deeply excavated, lateral margins sinuate, prominently ciliate, anterior angles nearly straight. Pronotum with a centrally raised portion which has a longitudinal channel. Scutellum raised anteriorly, transversely impressed about halfway back, then plane in posterior half. Mesopleurae striate, orifice of scent gland directed posteriorly at the apex.

Lateral margins of hemielytra slightly sinuate, ciliate.

Male genitalia in the form of an expanded backwardly directed cup with two processes sinistrally directed, these processes shorter and stouter than *P. mundula.*

The standard measurements of 6 specimens treated statistically (in microns) are:

	Mean	Standard deviation	Theoretical range	Observed range	Coeff. of variation
Head.					
Length of head	500·0±9·6	23·5±6·8	429·5–570·5	465–534	4·7
Length of head in front of eyes	183·3±3·6	8·8±2·5	156·9–209·7	172–189	4·8
Length of head behind eyes				52–103	
Length of eyes	222·8±4·7	16·3±3·3	173·9–271·7	207–241	7·3
Width of head across eyes	418·7±5·7	13·9±4·0	377·0–460·4	396–430	3·3
Width of eye	136·5±6·8	23·6±4·8	55·7–207·3	103–172	17·0
Interocular	167·6±5·5	13·6±4·0	126·8–208·4	121–172	8·1
Width of collum	295·6±10·2	25·1±7·2	220·3–370·9	275–310	8·5
Antennae.					
I				103–155	
II	426·4±9·8	32·8±6·9	328·0–524·8	413–500	7·7
III	278·6±3·6	8·1±2·5	254·3–349·1	275–293	2·9
IV	241·0±5·1	11·6±3·6	206·2–275·8	224–258	4·8
Rostrum.					
1 and II	262·0±6·0	13·6±4·3	211·2–302·8	207–276	5·2
III	174·8±2·8	6·9±1·9	154·1–195·5	172–189	3·9
Pronotum.					
Anterior width	367·3±22·0	54·0±11·7	205·3–529·3	293–430	14·7
Posterior width	889·5±16·3	40·0±11·5	769·5–1009·5	844–946	4·5
Median length	430·3±6·4	15·7±4·5	353·2–477·4	413–448	3·6
Lateral length	620·9±9·3	32·5±6·6	525·4–716·4	585–671	5·2
Scutellum.					
Anterior width	554·0±25·5	62·5±18·0	426·5–681·5	500–654	11·3
Median length	441·8±9·3	23·0±6·6	372·8–510·8	413–551	5·2
Lateral length	490·8±9·3	32·4±6·6	393·6–588·0	465–551	6·6
Legs.					
Coxa I	195·6±6·7	22·3±4·7	129·7–262·5	172–241	11·4
Coxa II	205·1±6·8	22·5±4·7	137·6–272·6	172–241	11·0
Coxa III	205·0±6·1	21·1±4·3	141·7–268·3	189–275	10·3
Femur I	571·4±20·2	64·1±14·3	379·1–763·7	602–688	11·2
Femur II	561·4±13·8	43·7±9·7	430·3–692·5	517–637	7·8
Femur III	631·0±17·4	60·4±12·3	509·8–752·2	671–774	9·6
Tibia I	560·4±5·9	17·7±4·1	508·3–612·5	534–602	3·2
Tibia II	560·3±12·5	39·5±8·8	450·8–669·8	517–637	7·0
Tibia III	812·1±23·3	77·4±16·5	579·9–104·4	602–947	9·5
Tarsus I I				34–52	
Tarsus I II				34–69	
Tarsus I III				86	
Tarsus II I				52–69	
Tarsus II II				52–121	
Tarsus II III				86–121	
Tarsus III I				52–69	
Tarsus III II				103–121	
Tarsus III III				103–138	
Claw I				34–52	
Claw II				34–52	
Claw III				34–52	

	Mean	Standard deviation	Theoretical range	Observed range	Coeff. of variation
Total length	2748±66·2	162·0±46·8	2362·0–3234·0	2580–4000	5·9
Total width	927·2±23·1	56·8±16·4	756·8–1097·6	880–1000	6·1
Length of abdomen	1222·0±53·3	130·5±37·7	830·0–1614·0	1050–1448	16·9
length of male genitalia				327–362	
Length of female genitalia				155	

Hemielytra exceed the length of the abdomen and therefore the quoted total length by about 140μ.

Loc. Fiji: Viti Levu (A. M. Lea, Holotype ♂, Reg. No. I 20068, Allotype ♀, Reg. No. I 20069, and 3 Paratypes, Reg. Nos. I 20070 and I 20067). Queensland: Cairns District (A. M. Lea, Paratype ♂, Reg. No. I 20066, all in S. Aust. Museum).

PHYSOPLEURELLA ARMATA Popp., 1909.

Fig. 3 J-L.

Physopleurella armata Poppius, 1909, Ac. Soc. Sci. Fenn., 37 (9), 12.

Physopleurella obscura Popp., *loc. cit.*, 13.

Yellowish brown, fairly shining above. Hemielytra dull with semi-erect sparse hairs. Beneath, first segment of antennae and tip of second, scutellum and legs darker.

Head with a prominent collum. The anterior margin of pronotum almost straight, posterior margin deeply excavate, lateral margins straight, ciliate, margined, anterior angles lying behind the collar, broadly rounded.

Scutellum depressed, hemielytra longer than the abdomen, clavus, corium and cuneus indistinctly punctate. Male genitalia composed of a large plate with short process on the left side placed on the edge and sinistrally and anteriorly directed (fig. 3 K).

The standard measurements (in microns) treated statistically from nine specimens are:

	Mean	Standard deviation	Theoretical range	Observed range	Coeff. of variation
Head.					
Length of head	558·2±12·4	37·1±8·3	446·9–669·5	482–602	6·6
Length of head in front of eyes	199·0±5·2	15·5±3·6	152·5–245·5	172–224	7·8
Length of head behind eyes				52–155	
Length of an eye	250·6±3·1	12·4±2·1	213·4–287·8	224–258	4·9
Width of head across eyes	476·3±4·0	12·0±2·8	440·3–512·3	448–482	2·5
Width of an eye				138–189	
Interocular	134·2±5·5	16·5±3·8	84·7–233·7	121–172	12·3
Width of collum	356·3±5·7	17·0±4·0	301·3–407·3	345–396	4·8

	Mean	Standard deviation	Theoretical range	Observed range	Coeff. of variation
Antennae.					
I				86–138 × 50	
II	447·6±5·3	22·1±3·7	381·3–513·9	413–482 × 50–60	4·9
III	259·6±4·8	16·0±3·4	211·6–307·6	224–275 × 20	6·2
IV	264·5±5·5	15·8±3·9	217·1–311·9	241–293 × 20	6·0
Rostrum.					
I and II	303·5±10·3	29·2±7·3	221·9–385·1	258–345	9·6
III	232·6±4·0	11·5±2·9	199·1–266·1	224–258	4·9
Pronotum.					
Anterior width	558·7±10·7	32·2±7·5	462·1–655·3	534–620	5·8
Posterior width	1071·0±12·1	40·0±9·4	911·0–1231·0	1017–1138	3·7
Median length	430·6±8·7	26·0±6·1	352·6–508·6	396–465	6·0
Lateral length	674·8±5·1	21·6±3·6	610·0–739·6	637–723	3·2
Scutellum.					
Anterior width	719·0±16·2	48·5±11·4	583·5–854·5	654–792	6·7
Median length	608·0±11·5	34·4±8·1	504·8–711·2	568–671	5·7
Lateral length	633·0±7·9	33·8±5·6	531·6–633·6	585–688	5·3
Legs.					
Coxa I	277·4±6·3	260·0±4·4	199·4–355·4	258–345	9·4
Coxa II	262·2±7·1	29·5±5·0	173·7–350·7	207–327	11·3
Coxa III	242·1±19·9	74·7±12·8		241–327	30·8
Femur I	631·8±12·8	52·8±9·0	473·4–790·2	620–723	8·4
Femur II	584·2±3·0	12·6±2·1	546·4–625·0	482–637	2·2
Femur III	722·7±16·4	63·8±11·6	531·3–914·1	620–826	8·8
Tibia I	580·1±6·3	26·3±4·5	501·2–659·0	534–620	4·5
Tibia II	504·7±11·0	43·9±7·7	373·0–636·4	482–602	8·7
Tibia III	873·7±13·3	55·1±9·4	708·4–1039·0	723–929	6·3
Tarsus I I				30–70	
Tarsus I II				52–86	
Tarsus I III				50–100	
Tarsus II I				30–70	
Tarsus II II				50–90	
Tarsus II III				70–120	
Tarsus III I				50–70	
Tarsus III II				90–100	
Tarsus III III				90–140	
Claw I				30	
Claw II				50	
Claw III				30–70	
Total length	3387·0±24·1	72·3±17·0	3170·0–3604·0	3170–3876	2·1
Total width	1147·0±22·8	68·3±16·1	942·0–1352·0	1030–1280	6·0
Length of abdomen	1753·0±21·5	64·4±15·1	1530·0–1946·0	1550–2150	3·8
Length of male genitalia				275–360	
Length of female genitalia				189–207	

Hemielytra exceed the length of the abdomen and therefore the quoted length by about 180μ.

Loc. Japan and New Guinea (*fide* Poppius). Queensland: Cairns District (A. M. Lea, in S. Aust. Museum). New South Wales: Gosford (in S. Aust. Museum).

PHYSOPLEURELLA BRIBIENSIS sp. nov.

Fig. 4 A, B.

Elongate oval. Above and below castaneous, cuneus and eyes darker. Legs possibly lighter.

Pronotum similar microscopically to *P. pacifica,* but the lateral margins are margined, straight with the anterior angles broadly rounded like *P. armata,* but not ciliate as in the latter. Scutellum anteriorly raised, transversely sulcate well behind the middle.

Mesopleurae striate, metapleural orifice curved strongly forward almost to fore margin of pleurite. Apex of abdomen without prominent long hairs.

The standard measurements (in microns) from one female are:

Head. Total length, 530; length in front of eyes, 170; length behind eyes, 160; length of an eye, 250; width of eyes, 470; width of eye, 130; interocular, 140; width of collum, 350.

Antennae. I, 120; II, 400; III, 250-260; IV, 220-230.

Rostrum. Missing.

Pronotum. Anterior width (across collar), 380; posterior width, 1,030; median length, 410; lateral length, 570-620.

Scutellum. Anterior width, 620; median length, 520; lateral length, 570-590.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	260–280	620–650	530	30	50–70	90	missing
II	220–260	500–570	480–530	50	70	100	missing
III	240–310	620–690	770	missing	missing	missing	missing

Total length, 2,970; width, 1,140; length abdomen, 1,640; length female genitalia, 210.

Closely allied to the following species in the very short hairs at the apex of the abdomen and almost glabrous sides of the pronotum, but in the shape of the pronotum it resembles *Ph. armata.*

Loc. Queensland, Bribie Island, Moreton Bay (Lea and Hacker, Holotype ♀, Reg. No. I 20063, in S. Aust. Museum).

PHYSOPLEURELLA AUSTRALIS sp. nov.

Fig. 4 C, D.

Elongate oval. Dark brown; middle of venter, tibiae and tarsi, rostrum, humeral angles of pronotum and hemielytra yellow. Pilosity golden. Eyes black, ocelli red. Head with a distinct collum, pronotum with a distinct though

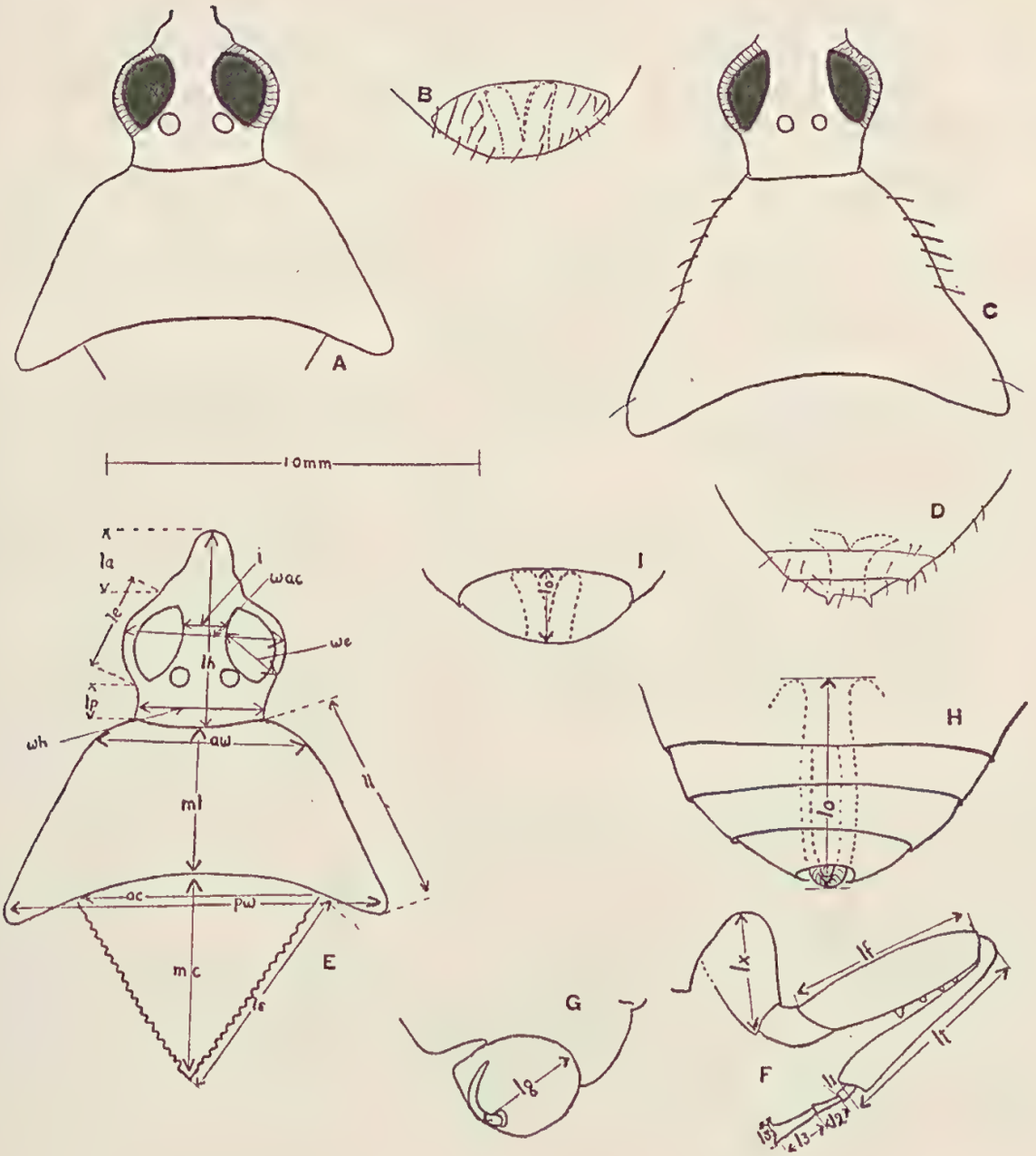

Fig. 4. A-B, *Physopleurella bribiensis* sp. nov. Female. A, head and pronotum; B, apex of abdomen from above. C-D, *Physopleurella australis* sp. nov. Female. C, head and pronotum; D, apex of abdomen. E-I, series of dorsal outline sketches showing methods of taking some of the standard measurements. E, head and pronotum, and I, apex of abdomen of female of *Physopleurella bribiensis* sp. nov.; F, fore right leg of *Oplobates femoralis* Reut.; G, apex of abdomen of male of *Physopleurella armata;* H, apex of abdomen of female *Xylocoris queenslandicus* sp. nov. (All enlarged 40 diameters.)

ac, anterior width of scutellum; *aw,* anterior width of pronotum; *i,* interocular; *l1,* length tarsus I: *l2,* length tarsus II; *l3,* length tarsus III; *la,* length of head in front of eyes; *lc,* length of claw; *le,* length of eye; *lf,* length of femur; *lg,* length male genitalia; *lh,* length of head; *ll,* lateral length of scutellum; *lo,* length female genitalia (or ovipositor when present); *lp* length of head behind eyes; *ls,* lateral length of scutellum; *lt,* length of tibia; *lx,* length coxa; *me,* median length of scutellum; *ml,* median length of pronotum; *pw,* posterior width of pronotum; *wac,* width of head across eyes; *we,* width of an eye; *wh,* width of collum.

tenuous collar, anterior margin almost straight, posterior margin deeply excavate, lateral margins sinuate, not conspicuously ciliate, and hardly marginate.

Scutellum slightly raised anteriorly, slightly impressed two-thirds of the way back. Sides of hemielytra not sinuate. Apex of abdomen without long hairs. Mesopleurae striate.

The standard measurements for one female specimen (in microns) are:

Head. Total length, 590; length in front of eyes, 210; length behind eyes, 120; length of eyes, 260; width across eyes, 470; width of an eye, 160-170; interocular, 140; width of collum, 310.

Antennae. I, 140 × 50; II, 460-480; III, 210 × 20; IV, 210-240 × 20.

Rostrum. I and II, 241; III, 172.

Pronotum. Anterior width, 360; posterior width, 1,020; median length, 500; lateral length, 650-700.

Scutellum. Anterior width, 670; median length, 590; lateral length, 550-640.

Legs	coxa	femur	tibia	tarsi I	II	III	Cl.
I	290–310	650–670	550–570	30	50	90	30
II	260–280	600–620	590–640	?	?	?	?
III	280–290	660–670	910–930	50–70	100	120–140	30–50

Total length, 3,570; total width, 1,170; length of abdomen, 1,810; length of female genitalia, 189.

Loc. Queensland: Cowell Creek (McNamara, Holotype ♀, Reg. No. I 20064, in S. Aust. Museum).

This species is allied to *Ph. bribiensis* in not having long hairs at the apex of the abdomen. The side of pronotum is sinuate and strongly ciliate, resembling in the latter respect *Ph. mundula, Ph. armata* and *Ph. pacifica,* and in the former *Ph. mundula* and *Ph. pacifica.*

MOLLUSCA OF THE OUTER HARBOUR, SOUTH AUSTRALIA

By BERNARD C. COTTON, Conchologist, South Australian Museum.

Plate xxiii and text fig. 1.

INTRODUCTION.

There is a rapidly-growing interest in shell collecting among students and school teachers in South Australia; this paper has been prepared, therefore, to explain how a typical beach may be explored.

One of the best places for shell collecting near Adelaide is in the vicinity of the Outer Harbour, situated about fourteen miles from the city. In a radius of one mile, at the tip of LeFevre Peninsula, is an area of river, mangrove swamps, estuarine mud-flats, weeds, rocks and stones. Practically all the variety of marine fauna a collector is likely to obtain in the upper protected waters of Gulf St. Vincent is represented here.

This account records where certain well-known molluscs live, as distinct from the many kinds one may find cast up haphazardly on the beaches after storms. Years of patient and experienced collecting are required to obtain the 300-odd species which live here.

Most of the shells mentioned are figured and briefly described in "South Australian Shells," published by the South Australian Museum, and sets of 35 mm. colour slides are being prepared under the auspices of the Museum and Visual Aid Section of the Education Department for exhibition in schools. The slides can be obtained by schools on loan through the Visual Aid Section and the explanatory text is contained in the publication mentioned.

Comparatively rapid changes have taken place on our beaches during the last few years through natural and artificial causes. The cumulative effect of recent violent storms coincident with high spring tides, protruding sea walls, and, to a lesser extent, minor sea level rise, have measurably modified the pattern of scouring deposition along this coast. At Glenelg and Henley Beach fine sand has been temporarily removed in places, exposing the remains of a mangrove swamp which flourished several thousand years ago in this area, during the Mid-Recent Period, when the sea-level was some 10-15 feet higher. At Brighton an old gum tree *in situ* was uncovered, and also an ancient whale skeleton.

Sand drawn from sand dunes at storm level and from the sea floor further south may re-cover these areas. Sand movement is essentially northwards; sand depositions are occurring at Outer Harbour, and finer materials are silting mangrove areas further north towards Port Wakefield.

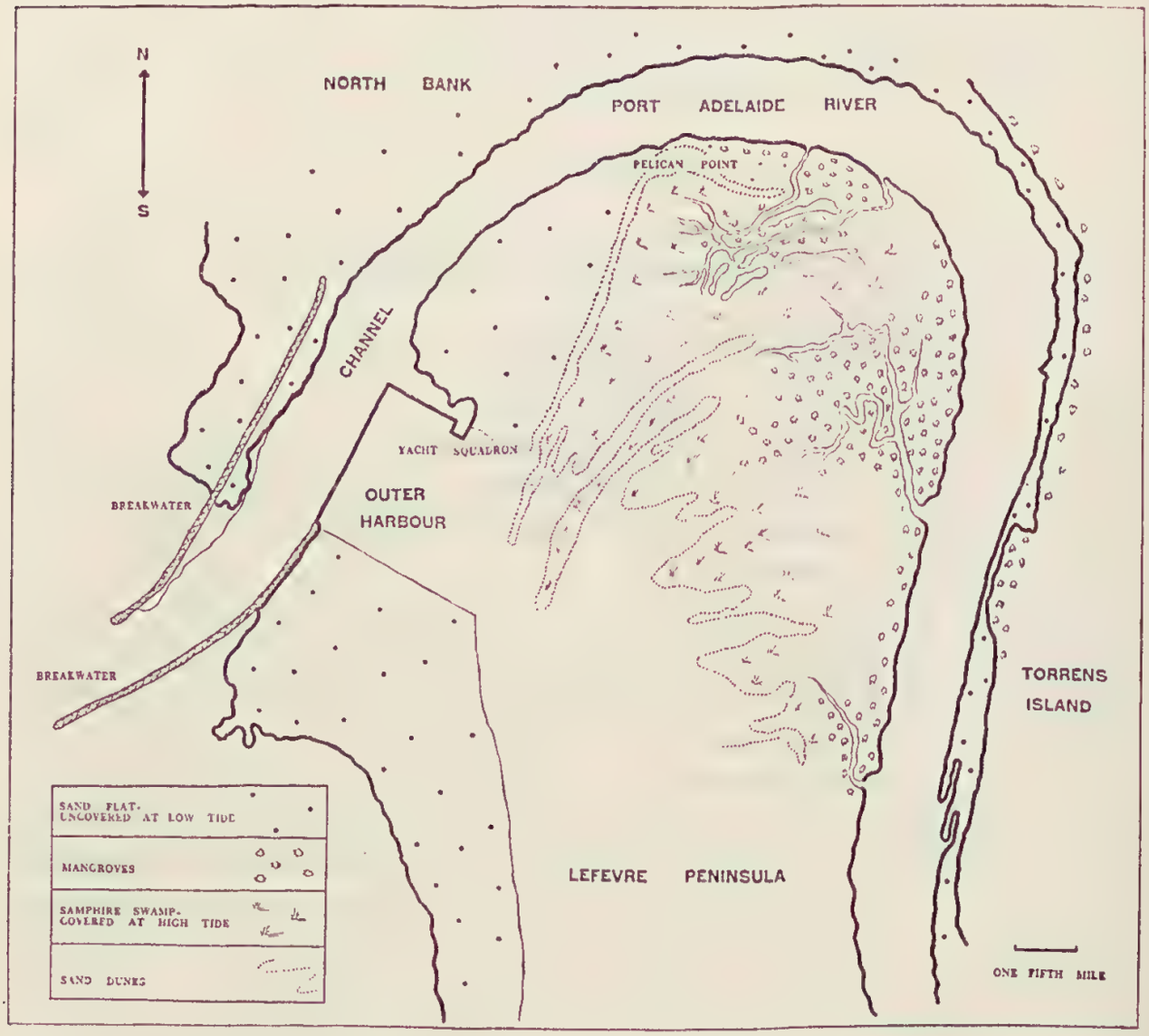

Fig. 1. Sketch map of the northern part of LeFevre Peninsula.

Within the next few years portion of the Outer Harbour surveyed here is to be entirely altered to form a "Greater Port Adelaide." It is, therefore, suggested that biological surveys of local beaches should prove instructive and valuable to future generations, following the rapid changes and obliteration of certain areas. Here a remarkable opportunity is presented to observe the continuous environmental adjustments which accompany changes in sea-floor configuration and the altered pattern of sand deposition.

OUTER HARBOUR.

At the southern end of the Harbour is a long stone breakwater about one mile long protecting the wharf and entrance channel to the Port River; facing and parallel to it is another similar breakwater on the opposite side of the channel. From the two breakwaters northwards extend sand-mud flats which are exposed at low tide. At the tip of LeFevre Peninsula there is a mangrove swamp, numerous small estuarine creeks, and a samphire swamp, inundated at high tide. Down the east coast of the Peninsula facing Torrens Island there are odd stretches of the Port River mudbanks, where industries have not obscured them. Such a river bank is at Snowden Beach in the south of the Peninsula.

In pl. xxiii, fig. 1, can be seen the two hundred acres of beach formed by silting south of the southern breakwater, and also, exposed at low tide, the sand and mud beach around the northern breakwater. In pl. xxiii, fig. 2, the sand and mud flat is on the right of the Royal Yacht Squadron Harbour, the raised bank of dead shell-sand is on the right of the raised circle, and the sand-mud flat of the northern bank is situated on the far side of the channel. Fig. 1 presents a sketch map of the northern part of LeFevre Peninsula.

SOUTH OF THE BREAKWATER.

Thirty years ago the bay in the south, adjoining the harbour projection, was filled with deep sea-water, but it is now silted up, forming a sandy beach. This southern breakwater has acted as a groyne, catching the drifting sand, and thus building up 200 acres of fine-sand beach. Foreshore walls further south along Gulf St. Vincent have aided scouring and the shallow layers of fine sand resting above old mangrove swamps are being carried northwards, exposing the mangrove mud on formerly attractive beaches.

At very low tide two shallow-water sandbanks beyond and parallel to the shore can be explored. On the outer bank lives the rare and attractive Frilled Cockle *Callanaitis disjecta,* the Heart Cockle *Cardium racketti,* the Feather Cockle *Tawera gallinula,* and the closely allied Grouse Cockle *Tawera lagopus* (the latter favouring deeper water), the Globular Ark *Veletuceta radians,* the Date Shell *Solemya australis* and the rarer Southern Finger *Solen vaginoides,* which protrudes from the sand at night time until early morning, rapidly burrowing immediately the early sun rays appear. In a muddy sponge lives the Doughboy or Prickly Scallop *Mimachlamys asperrimus,* and crawling on the sand is the Smooth Mitre *Vicimitra glabra,* the Triangle Murex *Pterynotus triformis,* the Sea-bubble *Quibbula tenuisimma* and the False Helmet *Hypocassis*

bicarinata. On the first or inside bank live colonies of the large White Cockle *Austromactra pura,* the Southern Cockle *Austromactra australis* and the Pink Sunset Shell *Tellina albinella* wedged in fine sand. Rarely, the King Scallop *Notovola alba* and, more frequently, the Queen Scallop *Equichlamys bifrons,* to which is sometimes attached the Southern Slipper *Zeacrypta immersa,* rest on the sand surface.

Near low water mark the Sand Cockle *Katelysia scalarina* digs itself in with almost invariably a tuft of "Tangle Weed" *Entero morpha intestinalis* on the protruding posterior end. High up on the sand flat near high tide mark is the Adelaide Triangle Cockle *Anapella adelaidae.* In certain areas this small white cockle is plentiful; it is good food, sweet and delicate in taste, but rather too small for anyone but a confirmed cockle connoisseur. Lower down the beach in pools left by the tide, just beneath the sand, lives the Small Wedge *Amphidesma angusta* and the Blunt Wedge *Amphidesma cuneata,* in quantity. Silver gulls can be seen "paddling" the wet sand at low tide making numerous depressions about nine inches in diameter. From the disturbed sand and water the gulls pick up food—Small Wedge cockles, minute Amphipoda, and other small crustaceans which live there. On clear areas nearby are sharp carved knife-like gashes in the sand. These are the tracks of the Small Wedge, and a specimen may be found half dug-in at the newer end of the cut. Preying on these small cockles is the red-banded Flame Borer *Niotha pyrrhus.* A cockle can be opened and used as bait to attract the Flame Borer and other carnivorous gastropods.

Washed up in sponges on this beach after storms is the White Lima *Austrolima gemina,* and sometimes also the Oriental Lima *Promantellum orientale* from deeper water, where it lives in colonies attached to broken Heart Cockles and Razor Shells, and also the Port Lincoln Oyster *Ostrea sinuata,* which grows particularly well when attached to accumulations of Razor Shell farther out. The light and delicate Wing Shell *Electroma georgiana* attached to weed is cast high up on the beach.

Dead shells of scallops, oysters, Heart Cockles, Dog Cockles, and even Bednall's Trigonia *Neotrigonia bednalli,* washed up from ten or fifteen fathoms, may have attached to the inner surface the tear-drop shaped container of the Flask Cockle *Gastrochaena tasmanica.* The container is composed of marine debris, shell fragments, Hydrozoa, Lace Coral, Bryozoa, and so on.

THE BREAKWATER.

When the tide is well out an examination of the lower rocks of the breakwater can be made. Most of the reef-living shells are found here alive in shallow water, the Round Back Sea Ear *Exohaliotis cyclobates,* Torr's Periwinkle *Austrocochlea torri,* Black Key Hole Limpet *Sophismalapas nigrita,* Common War-

rener *Euninella undulata,* Black Periwinkle *Nerita melanotraga,* Common Limpet *Cellana tramoserica,* Conniwink *Bembicium melanostoma* (which deposits groups of bean-shaped, jelly-like egg masses about one-eighth of an inch long on the surface of the sand, each capsule containing about 50 eggs), the Dog Whelk *Dicathais textiliosa* (with its numerous close-packed, small horny, tumbler-shaped yellow egg capsules attached to rocks or broken shell), the Rough Cockle *Chama ruderalis,* and the Rock Shell *Cleidothaerus albidus,* and sometimes the Thorny Oyster *Spondylus tenellus.* Below low-tide the Jingle Shell *Monia ione* is found attached to stones by means of the shelly plug which protrudes through a hole in the lower valve.

Some of the commoner chitons, for instance, the Lined Chiton *Ischnochiton lineolatus,* and Decayed Chiton *Heterozona cariosa,* cling to the rocks. In deeper water, on rocks further out, live the Peppered Cowry *Notocypraea piperita,* the rare Gruner Warrener *Euninella gruneri,* and the Lyre Shell *Lyria mitraeformis,* the last active at night and readily collected in number if a suitable light is available. Towards the end of the breakwater, attached to the rocks, the large Port Melbourne Mussel *Mytilus planulatus* has been taken, and also the Rostrate Mussel, *Brachyodontes rostratus.* In shallow water, attached to rocks, broken shell and debris, is a bed of Beak Mussels *Brachyodontes erosus,* solitary among the limy tubes of *Serpulidae* such as *Galeolaria caespitosa,* while imbedded in sponges is the Bearded Horse Mussel *Modiolus areolatus,* and less commonly the Ridge Mussel *Modiolus albicostus.* Other Serpulae tubes attached to rocks are the solitary *Galeolaria hystrix,* the little flat, spiral, *Spirorbis,* and the world-wide *Serpula vermicularis.*

Away from the breakwater to the south below low tide are meadows of the plants *Posidonia* and *Cymodocea,* giving a dark blue appearance to the water. In the latter lives the beautiful Pheasant Shell *Phasianella australis,* and these, when taken alive, have the delicate aperture of the shell undamaged and the shelly operculum in place, making them far more attractive to the student and collector. Many other weed-loving shells inhabit these meadows, such as the Spindle Shell *Colus australis,* the Waved Spindle *Propefusus undulatus* and Tulip Shell *Pleuroploca australasia,* with its small bell-like horny transparent egg capsules attached in groups to dead shells.

INSIDE THE BREAKWATER.

When the tide is particularly low an examination of the inside of the breakwater is well worth while. In the masses of weed growing just below low tide mark are the *Stenochitons,* which live only in Southern Australia. If you pull out a handful of the common strap-like weed *Posidonia,* beneath the sheath and near the root you will find the larger Weed Chiton *Stenochiton longicymba* which

should be carefully removed with the finger and thumb and placed in the collecting jar of seawater. so that it can be carefully tied down to a flat lath and dried in the laboratory. If removed and allowed to dry without this attention, it curls up tightly and cannot be straightened without fracture. All Chitons curl when removed from the water, the outer shell surface thus forming a protective covering. *Stenochiton longicymba* is in quantity at this locality. On the leaves of *Posidonia* may be found the small and inconspicuous Weed Limpet *Naccula parva,* and the Pilsbry Weed Chiton *Stenochiton pilsbryanus,* once called *Stenochiton posidonialis* from its habitat. Among the roots of the weed live the Milkstone Cockle *Venerupis galactites.* You may next observe a patch of wiry weed with a green leaf almost like that of an olive tree; this is *Cymodocea.* Pull out a bunch of the weed for on it live, beside the Pheasant Shell, a number of smaller weed shells belonging to the genus *Phasianotrochus;* the Small Necklace *Phasianotrochus irisodontes,* Red Lip Necklace *Phasianotrochus bellulus,* Sharp Necklace *Phasiantrochus apicinus,* the Hoop Shell *Thalotia conica,* the rare shining green Green Mouth *Odontotrochus chlorostomus* and the common Banded Kelp Shell *Bankivia fasciata* all occur on *Cymodocea.* If you examine the weed carefully you may find a very small and rare Slit Shell *Scissurona vincentiana,* or one of its relatives. The Dove Shell *Zemitrella lincolnensis* and its relations may also be present; in addition may occur the little Emerald Mussel *Musculus paulucciae,* also smaller Starfish, and the delicate spined Sea Urchin *Amblypneustes pallidus,* on which lives the glassy, curved commensal *Eulima commensalis.* On the stems of *Cymodocea* lives a small narrow Cymodocea Chiton *Stenochiton cymodocealis.*

NORTH BREAKWATER.

If a boat is available, an examination of the breakwater on the far side of the channel will produce worth-while results. Here will be found the reef-living shells, Limpets, Periwinkles and Warreners, like those on the south side of the breakwater previously examined, and in deeper water, crawling on sand patches at the south end of the sand pit and inside the breakwater, the Southern Olive *Oliva australis.* In addition one may see here on rocks below low tide the Flamed Limpet *Chiazaemea flammea,* the Seven Flame Limpet *Notacmea septiformis,* and Scaly Limpet *Patellanax squamifera,* the Marbled Limpet *Collisellina laristrigata,* the Worm Shell *Vermicularia sipho* (which incubates the eggs within the shell), the Split Worm *Siliquaria australis* with its bottle-cork like operculum and the Hammer Oyster *Malleus meridianus.* Hammer Oysters should be placed in water for 3 or 4 days, then scrubbed after removing the animal. Tie the shells together with string and dry and preserve the hair-like

byssus. Numerous blue Australwinks *Melarhaphe unifasciata,* Conniwinks *Bembicium melanostoma* and closely related species, and the Speckled Periwinkle *Fractarmilla concamerata* are found on the rocks, also the large Stronger Spined Sea Urchin *Heliocidaris erythrogramma,* sometimes carrying the commensal Brown Stylifer *Stylifer brunneus.*

The Sand and Mud Flats.

At low tide an expanse of sand and mud flats are exposed on the north and west side of the Royal Yacht Squadron Harbour. At low to half tide mark, on the banks of the channel leading to the Port River, live the three common cockles, the Sand Cockle *Katelysia scalarina,* the Mud Cockle *Katelysia peroni* and the rarer Corrugated Cockle *Katelysia corrugata,* favouring mud to sand respectively, all closely alike in appearance. Numbers of people are sometimes seen working with rakes, spades, or bare hands collecting these cockles at low tide for food and bait. They are collected and sold commercially bottled, soused in vinegar. The cockles live just a few inches below the surface when the tide is down. As an experiment, open a cockle shell and place it on the surface of the sand. In a few minutes the small Borer Whelk *Parcanassa pauperata* will appear nearby, or some feet away, and will approach the open cockle. Take out a pocket lens and watch the Borer Whelk insert its trunk-like proboscis into the flesh of the cockle. The radula or ribbon tongue with its minute teeth tear the cockle flesh to threads and pass it down the proboscis. The procedure can be easily watched under the lens. The Flame Borer, Lined Whelk *Cominella lineolata,* Small Ivory Whelk *Cominella eburnea,* Burchard's Borer *Parcanassa burchardi,* and even the Sand Snail *Uber conicum* may join in the feast. In pools left by the tide is Goldstein's Litozamia *Litozamia goldsteini.*

Just below the surface of the sand in a few inches of water when the tide is at its lowest lives the large cream coloured slug-like Ear Snail *Ectosinum zonale,* with a small ear-like shell on its back. Having a somewhat similar appearance, and living in a similar position, is the Angas Philine *Philine angasi,* with its delicate internal bubble-like shell and three strong internal gizzard plates for crushing the small shells which it eats. From November to February the peculiar gelatinous, balloon-shaped egg-capsule is found near the Philine, which burrows just below the sand. The egg capsule is two to three inches long and is attached to its sandy base by a thin filament. Beds of Razor Shell *Pinna dolabrata* occur in places such as at the northern entrance to the Royal Yacht Squadron Harbour and are exposed at extremely low tide. The shells

are anchored by the hairy byssus at the lower pointed end while the sharp and dangerous upper edges of the shell project above the surface. When collecting a few of these for the cabinet, preserve the hair-like byssus, soak it in tepid water until soft, place on a white blotting paper and stroke out with a camel-hair brush. Finally replace the byssus in the cleaned shell and gum into position. The animal is large and is moderately esteemed as food, particularly the large, creamy-white adductor muscle. On the Razor Shell crawl various common chitons, particularly the Oval Chiton *Ischnochiton contractus.* Attached to dead Razor Shells are found the Jingle Shell *Monia ione,* the Southern Slipper *Zeacrypta immersa,* the Port Lincoln Oyster *Ostrea sinuata,* and, anchored by the byssus, are numerous Hammer Oysters *Malleus meridianus.* Among the Razor Shells is found the Southern Cone *Floraconus anemone* (a relative of the larger tropical poisonous cones), the Triangle Murex *Pterynotus triformis,* the Queen Scallop and good specimens of the Round Back Sea Ear, with occasionally the Cap Limpet *Capulus australis* attached. Protected by and within the dead Razor Shells may be found the small Ringed Octopus *Hapalochlaena maculosa* and the Lined Squid *Sepioloidea lineolata.* Numerous eggs of the former are sometimes attached to the inner surface of the dead Razor Shell.

Below low water, amongst foul stones and weed, are the burrows of a shrimp *Axius plectorhynchus;* living in the burrows with the shrimp is the small and peculiar flat bivalve, the Moon Cockle *Ephippodonta macdougalli.* Adult specimens can sometimes be seen creeping about the stones during March and April. The shrimp burrow is marked by a light orange coloured sponge and the Pagoda Cockle *Myllita deshayesi* is also found in the burrow. The burrow seems particularly attractive to certain small incubatory commensal, nestling bivalves, for in it are found *Myllita tasmanica, M. gemmata, Kellia angasiana, K. australis, Marikellia vincentensis, M. yorkensis, Lepton trigonale, L. ovatum* and *L. australe.*

Buried deep in sandy mud is the large Hard Clam *Lutraria rhynchaena,* the shell gaping at the upper end, through which protrudes the trunk-like sheath containing the siphons. Nestling in the mud between tide marks is the gregarious, small, shining chestnut brown Variable Mussel *Modiolus inconstans* and occupying crypts in a friable consolidated shell-ooze in deep water is the burrowing Southern Date Mussel *Lithophaga cuneiformis.*

As the tide turns and rises examine the sand quickly from the water's edge to ten feet or so up the beach. Many species at this period crawl out to the surface or move towards the water. Among those ploughing in the sand are the Sunset Shell *Tellina albinella,* Rough Tellen *Pseudarcopagia victoriae,* Globular Ark *Veletuceta radians,* Date Shell *Solemya australis,* White Cockle *Austromactra pura,* the Southern Cockle *Austromactra australis* and Flinders Mac-

tra *Electromactra flindersi.* The Feather Cockle *Tawera gallinula* and the Grouse Cockle *Tawera lagopus* throw themselves out of the sand at the turn of the tide following low water.

The Double Ray Sunset *Soletellina biradiata* can be located by the semi-circular mark in the sand, as though a knife has been pulled along the surface. The mollusc is situated at the newer end of this cut and sometimes throws itself out when the tide approaches. On the surface is the Smooth Mitre *Vicimitra glabra,* False Helmet *Hypocassis bicarinata* and the Lyre Shell *Lyria mitraeformis.* Ploughing into the sand and leaving a coarse wavy track of disturbed sand is the Sand Snail *Uber conicum.* At the newer or more recently disturbed end of the track is a hump of sand and just beneath this occurs the Sand Snail. From November to February the Sand Snail's collar-like egg girdle of cemented sand, three or four inches in diameter, is plentiful on the beach. The numerous small eggs can be seen by transmitted light. The girdle is flexible when fresh, stiff and very brittle when dry.

PILES.

If while the tide is low old piles and wood structures are examined, near their base will be found attached massed colonies of the small Black Mussel *Modiolus pulex,* the Hairy Mussel *Brachyodontes hirsutus,* the Ark Shell *Arca pistachia.* Among the encrusting masses of Serpulae tubes, such as *Hydroides multispinosa* with its thin, white, brittle, limy tubes nestles, anchored by the byssus, numerous specimens of the rose-tinged Australian Kellia *Kellia australis* which retains and develops the young within the parent shell. Attached to and sometimes embedded in the piles are the limpet-like Southern Siphon *Siphonaria diemenensis.* Old piles and pieces from them are usually bored by the Long Southern Shipworm *Nototeredo edax* and the septate tubes can be seen lining the holes. The valves of the shells and pallets may be shaken out from dead specimens or removed from living ones.

Quantities of old wharf fenders and piles pulled up from the water front are to be found in the vicinity of the wharves. An examination of these will provide specimens of sedentary, boring and nestling types of Molluses, Cirripedia and other marine growths.

STONES.

At certain places on the sand-mud flats heaps of waterworn stones more or less encrusted with weed, such as the Sea Lettuce *Ulva lactuca,* and sometimes referred to by collectors as "foul stones," are uncovered at low tide. On these live the Lined Whelk *Cominella lineolata* and the Small Ivory Whelk *Cominella eburnea,* the Adelaide Whelk *Cominella adelaidensis* with its small acuminate

pouch-shaped egg-capsules, three-eighths of an inch long, blunt at the point and slightly expanded at the base, attached individually in irregular groups or lines following the depressions or cracks in the undersurface of the stones.

There is an apron of larger stones at the northern end of the main wharf on the southern bank of the Royal Yacht Squadron Harbour. These are "foul" or weed-covered stones where a good series of *Bembicium*, the Ray Limpet *Notoacmea septiformis*, together with some of its relatives, may be found alive near the water's edge between tide marks.

Mangrove Swamps.

Northwards is the entrance to the Port River at Pelican Point, where there are dense Mangroves *Avicenna officinalis*, with the mangrove fauna which is so consistent round the whole coastline of Australia. The only difference between the northern tropical areas and the southern is that the larger tropical Club Shell and a few other large warm water species are absent in the south. Crawling on the sandy-mud about the mangroves, and south of them in littoral pools, is the Smooth Creeper *Eubittium lawleyanum*, Estuarine Creeper *Batillariella estuarina*, and the Granular Horn *Zeacumantus diemenensis*, all in great quantity. On foul stones below low tide is the Granular Creeper *Cacozeliana granarium*. Among the mangroves crawl the Solid Air Breather *Salinator solida* and the common and more numerous Fragile Air Breather *Salinator fragilis*, distinguished by its thinner shell and different operculum; the last-named Air Breather will live in marine mangrove areas as well as in brackish to almost fresh water. Minute eggs of the Air Breather are cemented with grains of sand to form a small band or girdle, about one inch in diameter, deposited on the surface of the sand; the ova hatch in fourteen to sixteen days. Associated with these girdles are groups of about ten red eggs of an unidentified marine animal.

Attached to the limbs and on the finger-like pneumatophores is the Mangrove Conniwink *Bembicium imbricatum* and the Zebra Periwinkle *Austrocochlea zebra*. These species are also to be found in some of the small creeks in the north of the Peninsula, together with the Smoke Cockle *Eumarcia fumigata*.

Weed Channels.

North of the Royal Yacht Squadron Harbour and running across the mud flats to the Port River Channel is a weed channel along which the sea water flows in and out with the rise and fall of the tide.

Most of the weed-living shells abound here, as also does the Smoke Cockle *Eumarcia fumigata* in muddy situations, and the small mud-dwelling Stout Triangle Cockle *Anapella pinguis*, and, less numerously, the Triangle Cockle

Notospisula trigonella. On the Sea Grass *Zostera nana* crawls the Dunkers Clanculus *Isoclanculus dunkeri,* Yates Clanculus *Isoclanculus yatesi,* Adelaide Periwinkle *Chlorodiloma adelaidae* and the Yellow Dot Periwinkle *Chlorodiloma odontis.* Similar channels and creeks to the north of LeFevre Peninsula have a similar fauna.

A little north of the Royal Yacht Squadron Harbour is a slightly raised area of sand which is covered only at high tide. Here can be found at almost any time numerous species of dead shells in fairly good condition; about two hundred different kinds have been taken over some years by diligent collectors. One old gentleman spent years of his later life collecting and sieving samples of sand and sorting out the small shells. He found a goodly number of previously unknown species which would take a long time to examine, draw, and describe; so one may make a valuable collection here without getting the feet wet!

North Bank.

The North Bank is uncovered at low tide and will yield a typical sand flat fauna. Razor Fish beds, particularly on the north side, are more extensive here than on the mud flats, and the Ark Shell *Arca pistachia* is common on rocks, just below low tide, opposite Pelican Point in foul ground, mud and weed. Under foul stones lives the Pitted Keyhole *Cosmetalepas concatenatus* (usually in company with a grey Ascidian) and also the Shield Shell, Elephant Slug or Duck Bill *Scutus anatinus* (a large black creature with a white shell on its back hidden under the mantle), Wide Mouth *Stomatella imbricata,* False Ear Shell *Gena auricula,* Golden Star *Micrastraea aureum,* the Scale Star *Bellastraea squamifera,* the Beaded Top *Herpetopoma aspersa,* the Small Warty Triton *Cymatiella verrucosa,* the Waterhouse Triton *Cymatilesta waterhousei,* the Triangle Murex *Pterynotus triformis,* the Paivae Boring Whelk *Bedeva paivae,* and the Southern Cone *Floraconus anemone,* which can be found in the hollows beneath the stones. Some collectors maintain that our Southern Cone is capable of transmitting a mild sting. However, there has been no suggestion that it is a dangerous one, like that of the much bigger tropical cones. The Sea Bubble *Quibbula tenuissima* is common in felty weeds and muddy sand.

Port River.

In the mud banks of the Port River, at places such as Snowden Beach, Peterhead, North Arm and Torrens Island, live the Estuary Tellen *Macoma deltoides,* Paper Clam *Laternula recta,* Smoke Cockle *Eumarcia fumigata* and the Fragile Air Breather *Salinator fragilis,* while the Solid Air Breather *Salinator solida* is more common here than on the mud flats. Sandstone just below

low tide mark, and that dredged from the Port River, is sometimes bored by the Southern Piddock *Pholas australasiae,* and specimens may be removed alive by carefully breaking away the stone.

CONCLUSION.

It is helpful to obtain a tide table from the Harbours Board and to select particularly low tides when the rarer living material is desired. The falling tide should be followed out so that the species present under these conditions may be obtained and the maximum time allowed for low-tide collecting. As the tide turns and rises, and the collector moves shorewards, many species can be seen emerging from the sandbanks just above low tide. Incidentally, all species are edible if taken alive.

Many will remain alive for days in a jar of sea water, where they can be easily photographed or sketched; little is known about the living colours of many animals, and good work could be done in this direction. Methylated spirits will serve to preserve the flesh but not the colours. Formalin decalcifies the shell and should not be used for anything but shell-less Nudibranchs and most Cephalopoda. Chitons are taped to a flat stick to prevent them curling when drying, as this spoils them as cabinet specimens.

Fig. 1. Outer Harbour looking south, showing silting south of the breakwater.

Fig. 2. Outer Harbour looking west. Royal Yacht Squadron and raised sand area near the circle in the centre of the picture.

A CATALOGUE OF INTRODUCED SNAILS AND SLUGS IN AUSTRALIA

By BERNARD C. COTTON, Conchologist, South Australian Museum.[1]

Plate xxiv.

This paper is a record of land and freshwater molluscs introduced into Australia. Its main object is to stimulate interest in the collecting and identifying of introduced species.

Following a request from Dr. H. E. Quick, President of the Malacological Society of London, for land snails, the author collected many living specimens in South Australia and western Victoria. Series of these were sent to Dr. Quick for comparison with authentic material from type localities in overseas museums and for dissection, and he gives a brief review of the introduced land molluscs in the references cited. Identification is difficult, and a thorough anatomical study of the animal as well as a microscopic examination of the shell is required before any satisfactory conclusions can be reached. An exchange of authentic material has aided this work in South Australia. Introduced snails frequently show variation from the typical species.

The Common Garden Snail *Helix aspersa* is abundant in South Australia and variations in shell form and animal colouring occur. In later years there appears to be a greater percentage of pale pigmented specimens, some approaching the albino *exalbida,* odd specimens of which have been taken. Shells from the foothills are thinner and smaller of the *tenuior* variety, while some in the Torrens Valley area approach dark *nigrescens.* The largest specimens taken are from Kangaroo Island. Two sinistral specimens, one *cornucopia* and one *acuminata,* are in the Museum collection, taken locally. Soil, rainfall, temperature, period of colonization, original variety and other factors have been mentioned in connection with some of these variants, but no scientific investigation has been made locally.

Further species of land molluscs and, in addition, the freshwater species are recorded here as a preliminary basis for Australian workers. Numerous requests for identification of introduced species are made by government bodies to the agricultural departments, museums and universities, and it is presumed that similar questions are submitted to institutions in other States.

SLUGS.

MILAX GAGATES (Draparnaud) 1801.

Distribution. South Western Europe, Greece, Izium, North Africa, Atlantic Isles, British Isles.

Introduced. South Africa, Bermuda, Juan Fernandez, North and South America, New Zealand.

Australia. S.A., Vict., N.S.W.

Remarks. Jet Slug. Small Black Slug. Redescribed as *Limax maurus* Quoy and Gaimard 1824 from Port Jackson, *Milax tasmanicus* Tate 1880 from Tasmania, *Limax pectinatus* Selenka 1865, Sydney.

Time. Pleistocene to Recent. England.

LIMAX MAXIMUS Linne 1758.

Distribution. Europe to North Bergen, Transcaucasia, Baviois, Algiers, Atlantic Isles, British Isles.

Introduced. North America, South Africa, North and South America, New Zealand.

Australia. S.A., N.S.W., Vict., Tas.

Time. Pleistocene to Recent. England.

Remarks. Great Grey Slug.

LIMAX FLAVUS Linne 1758.

Distribution. Europe, Norway, Syria, Tripoli, Atlantic Isles, British Isles.

Introduced. North and South America, Japan, South Africa, New Zealand.

Australia. S.A., N.S.W., Vict., Tas., Q.

Time. Pleistocene, Cromerian to Recent. England.

Remarks. Yellow slug. Redescribed as *Limax megalodontes* Quoy and Gaimard 1824 from Port Jackson, *Limax olivaceus* Gould 1852 from Parramatta, and possibly *Limax bicolor* Selenka 1865 from Sydney.

LIMAX MARGINATUS Müller 1774.

Distribution. Europe, Greece to Finland and Eastern Russia, Iceland, British Isles.

Introduced. North America, New Zealand.

Australia. S.A.

Time. Pleistocene, Cromerian to Recent. England.

Remarks. Tree Slug. Sometimes referred to as *Limax* (*Lehmannia*) *arborum* Bouchard-Chantereaux 1837.

AGRIOLIMAX AGRESTIS (Linne) 1758.

Distribution. Northern Europe, Asia, Turkestan, China, Japan, North Africa, Syria, Atlantic Isles, Greenland, British Isles.

Introduced. Zanzibar, North and South America, South Africa, West Indies, Mauritius, New Zealand.

Australia. *S.A., N.S.W., Vict., Tas.*

Time. Pleistocene to Recent. England.

Remarks. Field slug. Redescribed as *Limax legrandi* Tate, Tasmania and *Limax molestia* Hutton, New Zealand.

AGRIOLIMAX LAEVIS (Müller) 1774.

Distribution. Europe, Northern Asia, North and Central America, British Isles.

Introduced. South America, West Indies, South Africa, Madagascar.

Australia. S.A., Q.

Time. Pleistocene to Recent. England.

Remarks. Marsh Slug. Smooth Slug. Recorded from the foothills of the Mount Lofty Ranges, near Adelaide. A synonym is *Limax queenslandicus* Hedley 1888.

AGRIOLIMAX RETICULATUS (Müller) 1774.

Distribution. Southern Europe, Asia, North Africa, Atlantic Isles, British Isles.

Introduced. North and South America, South Africa, New Zealand.

Australia. Vict., N.S.W., Tas.

Time. Pleistocene to Recent. England.

Remarks. Netted Field Slug.

ARION HORTENSIS Férussac 1819.

Distribution. Central Europe, northwards to Tromiso, North Spain, France, Italy, Netherlands, Russia, British Isles.

Introduced. North America, South Africa, New Zealand.

Australia. S.A.

Remarks. Garden Slug. The South Australian record is not definitely confirmed.

ARION ATER (Linne) 1758.

Distribution. Europe, Portugal, Italy, Balkans, British Isles.

Introduced. North America, New Zealand.

Australia. S.A., N.S.W., Vict.

Remarks. Large Black Slug.

TESTACELLA HALIOTIDEA Draparnaud 1801.

Distribution. North Africa, Western Europe, Belgium, Germany, Balearic Isles, Canary Isles, Madeira, British Isles.

Introduced. North America.

Australia. S.A., Tas., N.S.W.

Time. Holocene to Recent. England.

Remarks. Shelled Slug. Carnivorous Slug. Recorded from the Botanical Gardens, Adelaide. *Testacella maugei* Férussac 1819. Is a synonym.

SNAILS.

EUPARYPHA PISANA (Müller) 1774.

Distribution. Europe, Mediterranean, North Africa, Atlantic Isles, British Isles.

Introduced. North America, South Africa.

Time. Pleistocene to Recent. England.

Australia. Cottesloe, W.A., Vict., Geelong, N.S.W.

Remarks. White Snail. Now placed in the genus *Theba.* Specimens closely resembling this species and similar to those taken at Cottesloe, Western Australia, were found alive by H. M. Cooper on April 22nd, 1954, at Port Arthur, near Port Wakefield, S.A., on Boxthorn, about 200 yards above the high tide level.

HELICELLA ITALA (Linne) 1758.

Distribution. Europe to Petrograd, Transcaucasia, Algeria and Syria, British Isles.

Introduced. New Zealand.

Australia. S.A.

Time. Lower Pleistocene to Recent. England.

Remarks. Heath Snail. South-east of South Australia. Mentioned as introduced to South Australia by A. E. Ellis, "British Snails," 1926, p. 195. Originally recorded as *Helicella ericetorum* (Müller) 1821. Dr. Quick now identifies specimens from Yorke Peninsula as *Helicella (Xerocincta) neglecta,* mentioned below.

HELICELLA (XEROCINCTA) NEGLECTA (Draparnaud) 1805.

Distribution. Southern France, Italy, Germany, Greece, Syria, Algeria.

Introduced. British Isles.

Australia. S.A., Yorke Peninsula.

Time. Recent. England.

Remarks. White Heath Snail.

HELICELLA (CERNUELLA) VIRGATA (Da Costa) 1779.

Distribution. Western Europe, Mediterranean east to Crimea, British Isles.
Introduced. Australia.
Australia. S.A. "N.W.A. Foul Point" (Richardson, quoted by Musson), N.S.W., Vict.
Time. Pleistocene to Recent. England.
Remarks. Striped Snail. Recorded from vineyards at Northfield near Adelaide, South Australia. Dr. Quick identifies the S.A. records of *Theba pisana* as belonging to *H. virgata,* a synonym of which is *H. variabilis* Draparnaud, mentioning that "It is true the shell of the Northfield examples is more globose and the upper surface of the whorls flatter than in the British variety of this variable shell that I have seen, and the umbilicus is smaller than the typical."
Shells sent from Kangaroo Island are identified by him as *H. virgata depressa Requien* 1868, or *H. v. subaperta* Jeffreys. *H. virgata depressa* Requien 1848 was taken in 1953 at American River, Kangaroo Island.

HELICELLA (CANDIDULA) CAPERATA (Montagu) 1803.

Distribution. Europe to Crimea, Bagdad, British Isles.
Introduction. Australia.
Australia. S.A., Robe, Vict., Tas.
Time. Pleistocene to Recent. England.
Remarks. Wrinkled Snail.

HELICELLA (MICROSCEROMAGNA) STOLISMENA (Bourguignat) 1880.

Distribution. Spain, France.
Introduced. Australia.
Australia. S.A., South-east.
Remarks. A species named and described as *Helicella mayeri* Gude 1914 was taken on "Tea Tree" *Melaleuca,* at Millicent, South Australia. Dr. Quick thinks that the species may be *H. stolismena.* Living specimens are required to verify the identification. Although numerous shells are in the Museum collection from Millicent and Robe, no living specimens have been obtained in recent years. A synonym of *H. stolismena* is *Helix vestita* Rambur 1868 preoccupied by Ferrasac 1819.

HELICELLA HERIPENSIS (Mabille) 1877.

Distribution. Germany, France, British Isles.
Introduced. Australia.

Time. Pleistocene to Recent. England.

Australia. S.A., Adelaide foothills and S.E. S.A.

Remarks. Hedge Snail. Originally introduced into the South-east but now taken in the foothills of the Mount Lofty Ranges, near Adelaide, in gardens. Also called *Candidula gigaxii* (Charpentier) 1850. These may be *H. caperata*, the identification needs confirming.

COCHLICELLA ACUTA (Müller) 1774.

Distribution. South-western Europe, Mediterranean, British Isles.

Introduced. Australia.

Time. Pleistocene to Recent. England.

Australia. S.A., Yorke Peninsula, W.A., Cottesloe, Vict.

Remarks. Pointed Snail. Common at Stansbury and Minlaton, Yorke Peninsula, S.A., and Cottesloe, W.A. *Bulimus acutus* Müller 1774 is an older name for this species. Listed by Cox and Hedley, 10, p. 10, as *Helicella arbara* Linne 1889 from Victoria.

COCHLICELLA VENTROSA (Férussac) 1819.

Distribution. Mediterranean, Canaries, Azores, Bermuda.

Introduced. South Africa.

Australia. S.A., Yorke Peninsula, Mount Gambier, Adelaide; Vict., N.S.W., W.A.

Time. Recent.

Remarks. Swollen Snail. Recorded from Corny Point and the South-east of South Australia. Sometimes referred to as *C. ventricosa* (Draparnaud) 1831, pre-occupied. There are two variants in Adelaide gardens, *C. bizona* Moquin-Tandon and *C. inflata* Moquin-Tandon.

HELIX ASPERSA Müller 1774.

Distribution. Netherlands, France, Spain, Mediterranean, British Isles.

Introduced. North and South America, South Africa, New Zealand.

Australia. S.A., Vict., N.S.W., W.A.

Time. Pleistocene to Recent. England.

Remarks. Garden Snail. Common in gardens, general. Brightly coloured specimens with thick shells measuring 36 mm. in diameter are numerous at Muston, Kangaroo Island, according to a series taken by H. M. Cooper in February, 1954.

OXYCHILUS CELLARIA (Müller) 1774.

Distribution. Europe, Algeria, Rhodes, Armenia, Palestine, Persia, British Isles.

Introduced. North and South America, South Africa, New Zealand.

Australia. N.S.W., Vict., Tas.

Time. Pleistocene to Recent. England.

Remarks. Cellar Snail. Redescribed as *Helix sydneyensis* Cox, from N.S.W. Sometimes called *Helicella* and *Vitrea cellaria.* Actively carnivorous in Sydney gardens. Eats slaters and *Helix aspersa.*

OXYCHILUS ALLIARIUS (Miller) 1822.

Distribution. Europe, Algeria.

Introduced. America, South Africa, New Zealand.

Australia. N.S.W.

Time. Pleistocene to Recent. England.

Remarks. Mentioned by Ellis 1926, "British Snails," p. 244, as having been introduced into Australia and first recorded from Australia by J. S. Miller, 1822.

GEOSTILBIA APERTA (Swainson) 1835.

Distribution. Southern Europe.

Introduced. Australia.

Australia. Tas.

Remarks. Recorded from Australia by Petterd and Hedley, 1909.

VITREA CRYSTALLINA (Müller) 1774.

Distribution. Europe, north to Hamar Stift and east to the Caucasus, Algeria, Atlantic Isles, British Isles.

Introduced. Australia.

Australia. Tas.

Time. Pleistocene to Recent. England.

Remarks. Crystal Snail. *Vitrina* may prefer a carnivorous diet.

ZONITOIDES NITIDA (Müller) 1774.

Distribution. Europe, Algeria, Asia, Kashmir, Tibet, Japan, North America, British Isles.

Introduced. South America, New Zealand.

Australia. N.S.W., Tas., Vict.

Time. Pleistocene, Cromerian to Recent. England.

Remarks. Shiny Snail.

VALLONIA COSTATA (Müller) 1774.

Distribution. British Isles, Europe, North America.
Introduced. Madeira, Azores, South Africa, Palestine.
Australia. N.S.W., Tas., Norfolk Island.
Time. Pleistocene to Recent. England.
Remarks. Ribbed Snail. Known also as *Helix pulchella* Müller 1805, and redescribed as *Helix alexandrae* Cox 1868, from places about Sydney.

VALLONIA PULCHELLA (Müller) 1774.

Distribution. British Isles.
Introduced. South Africa.
Australia. N.S.W., Tas., Norfolk Island.
Time. Pliocene to Recent. England.
Remarks. Beautiful Snail.

SUBULINA OCTANA (Bruguière) 1789.

Distribution. America.
Introduced. England.
Australia. N.S.W.

FERUSSACIA FOLLICULUS (Gronovius) 1781.

Distribution. Mediterranean, South of France from the Pyrenees to the Riviera and in the Balearic Isles.
Australia. S.A., Linden Park, suburb of Adelaide.
Remarks. Inflated Ferussacia. This small snail was seen in great numbers on August 1, 1953, at Verdale Avenue, Linden Park, a suburb of Adelaide, by Colin F. Hutchinson. Groups of individuals were found in very damp places on a building block, under bricks, old cement bags or any other type of cover. The builder, Mr. Page, noticed them only during June and July of this year (1953) and thinks they were not present when the undergrowth was burnt off in January. There are no unusual weeds among the thick grass, and the few small olive trees are seedlings of the olive tree so common in this district since the early days of white occupation. All building materials used on the block are locally produced. There is no clue as to how the snails came here. Householders and children around the district have not seen the snails even in adjacent areas. There are no records of the species or anything like it from South Australia or anywhere else in Australia. It seems that the snail has been discovered and recognized soon after importation or dispersal, and immediate steps have been taken by the Agricultural Department to eradicate it.

The shell is about a quarter of an inch long, pupaeform, brown, highly polished. The animal has a long slender foot, slender tentacles, the upper pair bearing well-developed eyes. The foot is light yellow grading to light green, anteriorly and posteriorly, and the long slender tentacles and head are a dark grey shade. The snail moved rapidly from light into shade, and one would say, from its general appearances and habits, that it would not survive the heat and dryness of the Adelaide Plains. It would probably thrive in hot houses whence these specimens may have originated. It is prolific and ovoviparous, the young being formed in an egg and the egg hatched inside the parent. It is normally herbivorous, but is said to turn carnivorous when vegetable food is unobtainable.

On first sight the species was thought to be possibly *Cochlicopa lubrica,* which is abundant all over the British Isles, Europe, North America, Asia and North Africa. Dr. Quick kindly examined specimens sent by us to the British Museum and mentioned in correspondence that it was a *Ferussacia.* The species belongs to the family Ferussacidae, which is contained in the superfamily *Achatinacea,* including the family Achatinidae, and consequently has distant affinities with the Giant African Snail *Achatina fulica* Férussac, unfortunately so widely dispersed and uncontrollable. The family Ferussacidae contains some ten genera and numerous species.

HELIX SIMILARIS Ferussac 1819.

Distribution. Cuba, America, South Africa, China, Brazil, Singapore, Bengal, Mauritius, Java, Sandwich Islands.

Introduced. Frankland Isles.

Australia. N.E. Aust., N.S.W. (Sydney).

Remarks. This species appears to have been widely dispersed over the earth's surface. The Australian records are doubtful. Musson, 1890, writes, "Originally recorded for Australia from the Frankland Islands, collected by MacGillivray. Mr. Brazier, who had some of the original specimens, remarks that they are *H. aridorum,* Cox, 1867, or *Neveritis aridorum,* to give its latest name, and that it is a native snail, originally described from Clarence River, under logs in ironbark ranges, burrowing in dry weather."

OTALA VERMICULATA (Müller) 1774.

Distribution. Southern Europe and North Africa.

Introduced. Australia.

Australia. Tas.

Remarks. Recorded by Petterd and Hedley, 1909, as *Helix vermiculata* Müller 1774.

FRESHWATER SNAILS.

LYMNAEA PEREGER (Müller) 1774.

Distribution. Europe, North Africa, Asia, Kashmir, Afghanistan, Cape Verde Islands, British Isles.

Introduced. Tasmania.

Time. Pliocene to Recent. England.

Remarks. Wandering Snail. Redescribed as *Limnaea tasmanica* Tenison-Woods 1876, *Limnaea lutosa* Petterd 1889, and *Limnaea hobartensis* Tenison-Woods, 1876, from Tasmania.

LYMNAEA STAGNALIS Linne 1758.

Distribution. Europe, Asia, Afghanistan, Kashmir, North Africa, British Isles.

Introduced. Tasmania, South Australia.

Australia. Frequently seen in aquaria, but so far not established in any freshwater area.

Time. Pleistocene, Cromerian to Recent. England.

Remarks. Great Pond Snail. This snail grows very well in South Australian garden ponds and aquaria, but is not in our creeks and ponds.

PLANORBIS SPIRORBIS (Linne) 1801.

Distribution. Western Europe, Asia, North Africa, British Isles.

Introduced. Australia?.

Time. Pleistocene to Recent. England.

Remarks.—Button Ram's Horn. Sometimes named *Planorbis (Gyraulus) laevis.* Specimens of *P. spirorbis* Müller 1774, or more correctly *P. (Spiralina) spirorbis* Linne 1758, are labelled as Australian in the British Museum (Musson, p. 884).

PLANORBIS CAMPANULATUS Say 1821.

Distribution. North America.

Introduced. South Australia.

Remarks. Bell Planorbis. Specimens of this species were recorded by the author in the "South Australian Naturalist" 15, No. 1, p. 8, 1933, from Blanchetown, River Murray, where it was established. Mr. Oliver, Senior Resident Engineer, reported "that the shells referred to were found at approximately half a mile upstream (from Blanchetown), where the American machinery purchased

for lock construction was unloaded. This place is, however, a landing place for farm machinery and windmills of American manufacture."

This was the first record of a freshwater snail being introduced into the River Murray. I have seen no specimens at Blanchetown or elsewhere since 1933.

Petterd 4, p. 97, records that *Planorbis lacustris* is plentiful in "the freshwater streams near Melbourne." This species is probably a *Segmentina,* more recently named *Segnitila victoriae,* Smith, 1882, indigenous to the region.

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Top. Six views of *Ferussacia folliculus* emerging from the shell (× 6), Linden Park.
Below. Three views of the shell of *Ferussacia folliculus* (× 9).

TAXONOMIC NOTES ON AUSTRALIAN HAWKS

By H. T. CONDON* AND DEAN AMADON†.

INTRODUCTION.

THE primary purpose of the present paper is to contribute to the series of revisions of Australian birds which must precede any semi-stable Australian checklist. Peters' work (1931) often follows Mathews' treatment of races, and these taxonomic notes are to some extent a re-examination of the proposals of that author whose types, now contained in the American Museum of Natural History, were available for study.

Early students of the group, such as Gould (1865), Sharpe (1874), Ramsay (1876), and North (1912) were compelled to work with few specimens, and although unaware of the many confusing aspects of variability, the quality of their work was remarkably good considering the nature of their limitations. We have handled many hundreds of specimens which were not available to previous workers, but have found that much still remains to be learned and that further collecting in all parts of the continent is very necessary. Especially have we lacked material from Western Australia, southern Queensland and Tasmania, and these regions should prove profitable areas for investigation in the future. Subadult specimens greatly outnumber adults in museums, many skins are incorrectly sexed or poorly labelled, and certain well-marked forms are often represented by only one or two examples.

As pointed out by Mathews (1946), the single record of *Butastur teesa* from New South Wales is unconvincing and perhaps better placed on the suspended list.

Because of its long isolation, the Australian continent has served as an important area for differentiation in this order, as in others. One may mention such distinct and fine species as *Falco subniger* and *F. hypoleucos*. *Aquila (Uroaëtus) audax* is the largest and most striking member of the *Aquila chrysaëtos* group (or, for that matter, of the genus *Aquila*). The Milvinae are very well represented, not only by widespread forms, but also by two remarkable endemics, *Hamirostra melanosternon* and *Lophoictinia isura*. If present distribution means anything, Australia was the ancestral home or, at least, the focal point of the evolution and distribution of this group of kites.

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Some fossil forms were named by DeVis (1890 to 1911) from the Pleistocene of southern Queensland and northern South Australia, but the status of most of these is doubtful. The genus *Taphaetus* may be referable to *Aquila* or *Haliaëtus,* while Lydekker (1892) expressed grave doubts as to the validity of *Necrastur.* The identity of *Paleolestes,* named from a single toe-bone, is extremely problematical.

Our remarks are based on an examination of collections in the American Museum of National History (including the Mathews collection), the South Australian Museum, the National Museum, Melbourne (including the H. L. White collection), and the Australian Museum, Sydney, as well as certain material in the United States National Museum and the British Museum.

To the Directors of the various institutions for permission to study their collections are best thanks are due, and we are especially indebted to Messrs. H. G. Deignan, Washington, W. B. Hitchcock, Melbourne, and J. R. Kinghorn and J. A. Keast, Sydney, for assistance rendered.

The only Australian Acciptres not discussed in the following notes are *Falco (Ieracidea) berigora, Circus approximans* and *Pandon haliaetus.* The first-named species was recently revised by Condon (1951), and we have little to add to Amadon's earlier revision (1941) of the other two mentioned.

Abbreviations used: AM—Australian Museum, Sydney; AMNH—American Museum of Natural History, New York; HLW—H. L. White collection, National Museum, Melbourne; NMM—National Museum, Melbourne; SAM—South Australian Museum, Adelaide.

GEOGRAPHICAL VARIATION.

Variability due to geography is still incompletely understood in Australian birds, but correlation between environment and taxonomic characters and geographical variation is often marked, as in other parts of the world, and being parallel in many species, seems to confirm certain ecological rules that were put forward many years ago.

In the birds of prey the Bergmann effect may be conveniently demonstrated by the use of wing lengths; individuals of such species as *Accipiter fasciatus, Circus assimilis, Falco berigora, Haliastur sphenurus,* and *Pandion* are larger in the cooler regions of southern Australia and Tasmania than in other parts.

There is also a tendency towards richer and darker pigmentation in populations inhabiting regions of greater humidity (Gloger's Rule). Sometimes it is a case of the colour becoming paler in the more arid regions, when orthodox (internal) clines occur; *Accipiter cirrhocephalus, A. fasciatus, Falco longipennis,*

and *F. berigora* are examples in Australia. The heavily pigmented races of *Hieraaëtus morphnoides* and *Accipiter novaehollandiae* in New Guinea may be considered further examples of this law.

For reasons not yet understood, when species rather than races are compared, the ecological rules may receive little confirmation. Species more or less characteristic of the drier areas, such as *Elanus scriptus, Falco subniger,* and *Hamirostra melanosternon* are no paler than allied species of more humid regions, and in some cases are darker. It is possible, of course, that this may point to a very recent deterioration of climate, and that these dark forms arose during more pluvial or humid periods which are known to have occurred during the Tertiary.

Clines or "character gradients" are found in areas where continuous or unbroken chains of populations occur, more especially on continents and islands. The clines most easily demonstrated are those of size and colour.

The white-headed *Pandion,* or Osprey common to the East Indies and Australia, shows a clinal increase in size in southern Australia which led Amadon (1941) to recognize southern birds as a race, *cristatus.* Such procedure has, of course, been generally followed by taxonomists, as with, for example, the American sea-eagle *(Haliaëtus leucocephalus),* but whether such clines warrant nomenclatural recognition is more and more debated. In the case of *Pandion* of Australia, however, further material may show that there is rather an abrupt increase in size in the southern part of its range. If such a stepped cline can be demonstrated there should be less misgiving about admitting two races in the Australian region.

Stepped or external (inter-group) clines are not always readily apparent. In the Goshawk, *Accipiter fasciatus,* the difference in size in northern birds is abrupt, and the birds resemble more closely in colour some of the insular tropical forms rather than members of populations inhabiting the major portion of the continent. This suggests that the small northern race, *didimus,* could be a derivative of some island form and a rather late entrant to the Australian mainland.

However, one cannot always assume that small northern races outside Australia, as in *Accipiter fasciatus* and *Hieraaëtus morphnoides,* are an extension of the size trend discernible in Australia, for such species may have large races on some of the other (i.e., other than New Guinea) tropical islands. The population of *Accipiter fasciatus* on Rennel Island, an outlier of the Solomons, is fully as large as and apparently indistinguishable from the goshawk of southern Australia, and the races of this hawk on New Caledonia and the Louisiade Archipelago are comprised of birds almost as large. Possibly factors other than

temperature response may play the dominant role in directing changes in the bird populations of small islands.

While almost nothing is known of migratory movements, certain Australian hawks may wander far from their normal habitat. For example, it would appear that the Brown Goshawk of southern Australia may visit the Kimberley division in the north, and the falcons *Falco longipennis* and *F. c. cenchroides* occur as non-breeding stragglers to various islands north of Australia, and the latter also visits New Zealand at times.

The distribution of the diphasic goshawk, *Accipiter novaehollandiae,* in Australia and New Guinea is a special problem, for whose analysis one may consult Southern and Serventy (1947). The white phase has become exclusive in Tasmania, but elsewhere, though geographical variation occurs, there is little of regular clinal nature in the distribution of this phase. The fact that the grey phase has never been recorded in Tasmania indicates that in this species isolation is reasonably complete on that island. Also, the hawks of this genus, in parts of the world where they are non-migratory, show more geographical variation than do most other genera and are presumably more sedentary than most others. As might be expected, Tasmanian subspecies are particularly well-marked in small song birds, but in the hawks not enough collecting has been done in most species to enable satisfactory studies to be made of material from this region, although in certain instances there appear to be no differences between specimens from the island and the adjacent mainland.

DEVELOPMENT.

Study of plumage changes due to age is important in taxonomic work. In the Accipitres the downy chick is usually whitish, but in *Elanus* it is pale brownish or grey. Sexual dimorphism is generally great, females being larger, except perhaps in *Elanus* where no striking differences have been detected. Juvenals of both sexes may be markedly different from the adult, and the moult into adult plumage may be direct, as in *Elanus, Aviceda, Accipiter cirrhocephalus, Falco hypoleucos,* and *F. longipennis,* or take several years as in *Aquila, Haliaëtus, Accipiter fasciatus, F. berigora, F. peregrinus,* and *F. cenchroides.* Owing to the protracted moult in the species quoted, confusion may be caused through superficial examination or insufficient material, and a proper understanding of the factors responsible for individual variation by ornithologists whose chief interests lie in other directions is desirable in order to make their observations of value. For instance, in the Brown Hawk young birds are usually dark, even when in breeding condition, yet they have often been confused with dark

phase adults. In the Kestrel, also, both sexes may have reddish tails when young, and the young of the sea-eagles *(Haliastur* and *Haliæëtus)* might be mistaken for other species. Immaturity in goshawks and falcons is indicated by the markings of the rectrices, and since these are usually the last feathers to be replaced at the moult, a good idea of the age of cabinet specimens may be obtained.

Genus ELANUS Savigny 1809.

Type. *Elanus caesius* = *E. caerulus*. Old and New Worlds. (Four species.)

Of all the major regions, Australia alone has two species of *Elanus*. However, this does not necessarily mean that the genus originated in Australia, but merely that we are dealing with an example of double invasion or double colonization at long intervals.

Were it not for the occurrence of two species in Australia, species that are, moreover, very similar to each other, some might prefer to unite all members in a single species. Furthermore, *notatus* is more like *leucurus* of America than it is like *caeruleus* of the East Indies, Eurasia and Africa. Twice in the past and at two widely separated intervals this genus invaded Australia, presumably from the north, thus giving rise to the two species endemic there. Present day distribution of the two species, and the resemblance of *notatus* to *leucurus* of the New World, suggests that the first-named was the earlier arrival in Australia. Unusual, also, is the recent discovery of a local endemic race of *E. caeruleus* in New Guinea (Mayr and Gilliard, in press, Bull. Amer. Mus. Nat. Hist.). Presumably this species is a newcomer to New Guinea.

ELANUS NOTATUS Gould.

Elanus notatus Gould, 1838, Syn. Bds. Aust. part 4, app. p. 1: New South Wales.

Elanus axillaris parryi Mathews, 1912, Nov. Zool., 18, p. 251: Parry's Creek, northwestern Australia. Type: AMNH No. 531543; adult male; January 27th, 1909; J. P. Rogers. Wing, ? (moult); tail, 142 (worn). Coloured plate of type: Mathews, 5, plate 249, opp. p. 199.

Range. Australia; not Tasmania.

The Black-shouldered Kite has a wide distribution in Australia and appears to be a true nomad, although in many districts one or more birds will remain for weeks, or even months, before moving on. In Western Australia it is regarded as a typical inland species, whereas in eastern Australia it is perhaps just as numerous in coastal areas.

In northern Australia it has been reported at Katherine River, Northern Territory, and Barnard at one time found it breeding in the McArthur River district. In the lower Northern Territory, it was allegedly seen by members of the Horn Expedition in 1894, and in 1911 it was reported by the Barclay Expedition at Idracowra; in 1914 S. A. White believed he saw the species near Chambers' Pillar.

As might be expected, no evidence of geographical variation has been found over the entire range.

The opinion has been expressed that the black "shoulder" (lesser wing coverts) is larger in this species than in *scriptus,* but actually the reverse may be the case in fully adult birds. In *notatus,* also, the true outer primary (small and concealed) is white on the outer web and grey on the inner, whereas in *scriptus* this feather is uniformly grey.

In his account of the American species, *leucurus,* Friedmann (1950, p. 71, footnote) wrote: "It is rather remarkable that there should be no sexual difference in size . . . . since Mathews . . . . finds females to be larger than males in *Elanus notatus* and *E. scriptus.*" Actually, however, the number of specimens of *scriptus* in Mathews' collection (five) is too few to determine this point, while in *notatus* the females, if really larger, are only very slightly so, as shown by the following measurements of adults.

Wing.	11 ♂, 289-302 (298);	15 ♀, 293-310 (300·5) (AMNH).
	12 ♂, 280-298 (290);	3 ♀, 280-298 (289) (SAM).
Tail.	7 ♂, 142-152 (147);	9 ♀, 142-154 (149) (AMNH).
	12 ♂, 143-153 (149);	3 ♀, 148-154 (152) (SAM).

Weights of a pair of adults taken on June 28th by K. Buller were: ♂ 270 grammes; ♀ 250 grammes. This would suggest that the sexes are about equal in size.

From the earliest stages, when the tail is very short, nestlings of *notatus* may be distinguished from those of *scriptus* by the much greater extent of black on the under-wing coverts in the latter.

At the time of hatching, young *notatus* are covered in pale brownish-coloured down, which changes within a fortnight to a smokey-grey colour. At this stage the position of the black shoulder is indicated by a bare patch of skin of dark bluish colour, perhaps caused by the unerupted dark feathers beneath. It is not known if a similar marking occurs in *scriptus.* In the week-old nestling, the iris has been observed to be hazel, the cere bluish, and the legs flesh-coloured. In a bird a fortnight old the iris was dark brown, the cere bluish-green, and the legs pale yellow.

Juvenals of *notatus* differ markedly from the adult. The top and sides of the head are rich brown and the back is brownish-grey with white tips to the feathers. The shoulder is dark grey with many of the feathers tipped with white and the black patch under the wing is less extensive than in *scriptus*. The upper breast is washed deep buff (formed by coloured tips to the white feathers), with dark brown central shafts; it becomes paler with wear. The iris at this stage is light brown, cere yellow, legs and feet bright yellow.

In several adults of both sexes the iris has been recorded as red, cere yellow, legs and feet yellow.

ELANUS SCRIPTUS Gould.

Elanus scriptus Gould, 1842, pt. 9, 1, pl. (24); South Australia. (Mathews, 1927, p. 259, gives the further restriction of Cooper Creek.)

Elanus scriptus victorianus Mathews, 1917, Austral Av., Rec., 3, p. 70; Victoria. Type (no field label): AMNH No. 531575; adult male; December, 1902. No collector is given, but it may have been A. Coles, who is mentioned as the collector of some specimens entered near the present specimen in Mathews' manuscript catalogue. Wing, 293; tail, 150. Coloured plate of type: Mathews, 5, plate 250, opp. p. 208.

Range. Normally confined to the dry interior of the Australian mainland. In abnormal seasons some birds reach the coastal districts of New South Wales, Victoria, South and Western Australia; not recorded from Tasmania.

The Letter-winged Kite, unlike its congener, is a gregarious species which nests in colonies (Jackson, 1919). In South Australia it is found in the north-east, from Minnie Downs, Lake Eyre, Manuwalkaninna, and Lake Callabonna to Moolawatana (near Lake Frome), an abnormal occurrence in 1952 being from Butler, Eyre Peninsula. Previously unknown from Western Australia, during the "southern invasion" of northern and central birds in the years 1951-53, this kite was reported from such widely separated localities as Adele Island (near Yampi) and Esperance, as well as the Pilbara district, and north and east of Perth (Serventy, 1952, 1953).

Although specimens have been taken near Dubbo and at Melbourne (Moonee Ponds), generally speaking, alleged occurrences in southern Australia prior to 1951 should be treated with caution.

In describing *victorianus* Mathews gave no characters, merely referring to his plate and description of the specimen from Victoria in his "Birds of Australia." There he had made no attempt to differentiate Victorian birds from those of other regions, but was merely describing the specimen as a representative of the species. It is unlikely that any geographical variation exists.

Probably *scriptus* is a slightly larger bird than *notatus*, because all the wing lengths of females measured are near or above the maximum found in a considerable series of *notatus*. The wing of the type of *victorianus* is not in very good condition for measurement.

Wing. ♂ (type of *victorianus*) 292 (AMNH).
♂ (breeding) 296; (juv.) 287 (HLW).
♀ 308, 311, 313 (AMNH).
♀ (subadult) 310 (AM); (breeding) 302, 305; (juv.) 302 (HLW).

Tail. ♂ ("*victorianus*") 150; 146 (AMNH).
♀ 162 (AM); 156 (HLW).

When fully adult, *scriptus* is a rather whitish-looking bird. Perched, the only means of distinguishing it from *notatus* would be by the larger black shoulder and somewhat paler grey back, both rather difficult characters to observe in the field. The bill averages slightly deeper and heavier in *scriptus* than in *notatus*. Dr. Ernst Mayr has pointed out to us that whereas in the latter the outer visible primary is two centimetres or more longer than the fourth, in *scriptus* the difference is much less, and these two primaries are usually subequal; this difference was constant in all material examined.

Mr. Warren Hitchcock has drawn our attention to a series of skins in the H. L. White collection, showing fourteen stages in the development from newly-hatched young to breeding adult. On hatching, the chick is greyish with dark (blackish) eyes, and after about seven days the head and breast become white. Later, the scapulars appear as brownish feathers, and the back is also brown. In the short-tailed nestling of about one month, the head assumes the same brown colouration as the back, and the black shoulder and under-wing coverts are well-developed. At this stage the eyes are pale brown, cere pale horn, and legs and feet pale yellow. The tail, grey at first, becomes progressively more whitish as it lengthens, and as the bird approaches adult size the rufous upper breast becomes paler. The black shoulder and under-wing markings, which are strongly developed at an early age, increase in extent, while the head and back become more whitish as the bird develops. With the completion in growth of the tail, the rufous breast disappears, the back remains brownish, but the head is white, and the primaries are broadly tipped with white. The irides at this stage have changed to a reddish-brown. In a comparable stage in *notatus* the head is streaked with brown and the edges of the secondaries, as well as the primaries, are broadly tipped with white.

The colours of the soft parts of adults are similar to those of *Elanus notatus*.

Genus AVICEDA Swainson 1836.

Type. *Aviceda cuculoides*. Synonyms include *Baza* Hodgson 1837, *Lepidogenys* Gould 1838, *Lophastur* Blyth 1842, and *Nesobaza* Mathews 1916. Australian, Ethiopian and Oriental Regions (five species).

The name *Aviceda* antedates *Baza* which, until recently, was in general use.

AVICEDA SUBCRISTATA (Gould).

Aviceda subcristata subcristata (Gould).

Lepidogenys subcristatus Gould, 1838, Syn. Bds. Austr. part 3, plate (46) and text; New South Wales.

Baza subcristata queenslandica Mathews, 1912, Nov. Zool., 18, p. 251; Mackay, Queensland. Type: AMNH No. 531727; adult female. There is no original label, but in Mathews' manuscript catalogue, where this specimen is No. 6392, it is indicated that it was one of a lot of skins obtained from Gerrard (a London dealer) in 1911. Wing, 341; tail, 209.

Lophastur subcristatus kempi Mathews, 1916, Bds. Austr., 5, p. 220; Skull Creek, Cape York. Type: AMNH No. 531725; adult (?) female; December 22nd, 1912; Robin Kemp. Wing, 327; tail, 213.

Range. Coastal northern Australia eastward and south to the northern rivers of New South Wales.

The Crested Hawk is of northern distribution in Australia, and one would not expect birds that have penetrated a short distance into New South Wales to be separable from those of Queensland, nor do they seem to be. Hartert (1931, p. 44) reached a similar conclusion, but Peters (1931), following Mathews' "Systema," recognized *queenslandica* with *kempi* a synonym, as distinct from nominate *subcristata* of New South Wales. Measurements of specimens (some probably wrongly sexed) may indicate a clinal sequence, the largest examples being from New South Wales.

The bird figured in Mathews (1916, plate 251) is unusually rufous on the abdomen, but is matched by at least three of sixteen skins from Queensland in the American Museum. There seems to be considerable variation as regards the tone of this rufous or buffy suffusion, but it may be largely age variation and fading rather than individual variation. Freshly moulted birds are darker generally. Six skins have been seen by us from New South Wales, one without more restricted locality, one from Goondiwindi, one from Clareville (Pittwater), two from Richmond River and another from Casino, not far south of the Queensland border.

In New Guinea there are three races of this hawk, *stenzona* and *waigeuensis* in the west and *megala* in the east, which differ chiefly in size (Mayr, 1940, p. 7-8). Eastern Australian birds are larger than the New Guinea races, and the grey of the breast and ventral stripes or barrings are paler.

Sexual dimorphism seems to be somewhat reduced in the Australian birds, although material is not well enough labelled to work out the details, more particularly since wear is so great or moult is so protracted in this species that some portions of the plumage of many Australian specimens are badly bleached and foxed.

Little is known of the occurrence of the Crested Hawk in the Northern Territory, but it has been reported from the Darwin area and as far south at least as Adelaide River township. Condon, during the years 1943-1944, found it a rare species and observed it only at Batchelor, about 50 miles south of Darwin. It was reported from the lower Northern Territory, at Palm Valley, by Whitlock in 1925, but this record must remain doubtful as it has not been seen by other visitors to this area.

There is a single record from the Kimberley area, Western Australia, and examination of the specimen obtained suggests that a distinct geographical race occurs in that region, and to which Territory birds may also belong.

AVICEDA SUBCRISTATA NJIKENA, subsp. nov.

Type. HLW 8329, Nat. Mus., Melbourne; adult male, fresh plumage; Fitzroy River, Western Australia; August 8th, 1924; F. L. Whitlock collector.

Wing, 310; tail, 192; tarsus, 30. "Iris golden yellow (eyes very prominent), bill bluish, culmen darker, legs drab" (from field label).

Diagnosis. Smaller than eastern Australian birds (wing ♂ 310, against 321-348); top of head dark blue-grey, face blue-grey, generally darker above; less grey on hindneck (collar) and upper back; barrings on breast blackish-brown, without rufous tinge; some rufous on foreneck; under tail coverts deep ochraceous as in *A. s. subcristata;* rump dark slate-grey, also retrices, with blue-black barrings and terminal band. *Njikena* is the tribal name of the aborigines inhabiting the area where this bird was collected.

In general appearance and size the type of *njikena* seems closest to *bismarckii* of the Bismarck Archipelago. The closest race geographically is *timorlaoensis,* which occurs in the island chain from Lombok to Timorlaut, but it is smaller still than *njikena* and the cross-barrings are more as in *s. subcristata.* Another form, *pallida,* from south-east and Kei Islands, is also small, but lacks the blackish tone in the barrings, while typical *stenzona* from Aru Islands and western New Guinea has blackish barrings and pale ochraceous under tail coverts.

Whitlock, in his account of his trip to the Fitzroy River (1925), stated that he believed he saw the mate to the bird described above. The species is very sedentary, ten subspecies being known from the islands to the north of Australia. Wing measurements:

New South Wales. ♂ 329; ♀ 358 (AMNH).
♂ 328, 329, 329; ♀ 345 (AM).
Queensland. 12 ♂, ♀ 321-344 (332·5) (AMNH).
3 ♂ 340-348; ♀ 320, 332 (SAM).
Western Australia (type of *njikena*). ♂ 310 (HLW).
Eastern New Guinea and islands (*megala*, from Mayr, 1940, p. 8).
8 ♂ 298-313 (307·4); 8 ♀ 314-334 (323·5).
Western New Guinea, Aru and other islands (*stenozona*, from Mayr, *loc. cit.*).
8 ♂ 290-303 (296·8); 5 ♀ 296-314 (305·6).
Waigeu Island (*waigeuensis* Mayr, 1940, p. 8). ♀ 314-319.
South-east and Kei Islands (*pallida*, from Stresemann, p. 305).
♂ 286-295; ♀ 300-314.
Lombok to Timorlaut, etc. (*timorlaoensis*, Stresemann, *loc. cit.*).
♂ 295-306; ♀ 310-327.
Bismarck Archipelago (*bismarckii*, Stresemann, *loc. cit.*).
♂ 309-312; ♀ 317-330.

In young birds of *H. s. subcristata* the grey breast is lacking and the cross-barring are much narrower than in the adult, while the upper surfaces are brownish, perhaps accentuated by fading and wear.

Genus MILVIUS Lacépède 1799.

Type. *Falco milvus*. Old World (two or three species).

MILVUS MIGRANS (Boddaert).

Milvus migrans affinis Gould.

Milvus affinis Gould, 1838, Syn. Bds. Austr., part 3, plate (47, fig. 1) and text; Australia (restricted to New South Wales by Mathews, 1916).

Milvus korschun napieri Mathews, 1912, Nov. Zool. 18, p. 249; Napier, Broome Bay, Kimberley Division, Western Australia. Type: AMNH No. 532065; adult female (no date given); G. F. Hill collector; wing 408, tail (long outer feathers), 252.

Range. Lesser Sunda Islands, Timor, Celebes, New Guinea, Bismarck Archipelago. In Australia mainly north of about 20° south latitude.

It is probable that the Black Kite is only a recent arrival in the north of Australia, one which may yet establish itself in the south as a result of large scale radial dispersal movements during abnormal seasons (see Serventy, 1953).

We have compared specimens from the Celebes, the Lesser Sundas, New Guinea, and various parts of Australia without detecting geographical differences.

Although sexual dimorphism is slight, recently collected material shows that the bill is shorter and more strongly hooked in the male than in the female.

Genus LOPHOICTINIA Kaup 1847.

Type. *Milvus isurus;* Australia (one species).

The single member of this monotypic genus bears a strong resemblance to the Red Kite (*Milvus milvus*) of Europe, and were it not for the fact that the latter has transverse scutes down the front of the tarsus, while *isurus* has reticulations, one might be inclined to assign the Australian bird to the genus *Milvus*. Although the nature of the tarsal covering is undoubtedly a rather variable character when well-marked differences occur among closely related forms (the scales are reticulate in *Hamirostra* also), they must be given importance. In *Lophoictinia* the coracoids are distinctive, being short and relatively wide and heavy, and the right coracoid overlies ventrally the left, which is the reverse of the condition of the pectoral arch met with in *Aquila, Circus, Falco,* and *Hieraaëtus*. Instead of overlying one another, the coracoids just touch in *Milvus, Haliastur* and the unrelated *Elanus*. We have no skeletal material of *Hamirostra* for comparison.

Published records and notes on stomach contents indicate that this species is a persistent hunter of birds, and probably also a nest-robber. In its actions it has been likened to a harrier, and possibly it is mistaken at times for one in the field.

LOPHOICTINIA ISURA (Gould).

Milvus isurus Gould 1838, Syn. Bds. Austr., part 3, plate (47, fig. 2) and text; Australia=New South Wales, according to Mathews, 1916.

Milvus isurus westraliensis Mathews 1912, Nov. Zool., 18, p. 250, Perth, Western Australia. Type: AMNH No. 532146; adult male; November 7th, 1904; "Dr. Kelsall"; wing, 455.

Range. Australian mainland.

The Square-tailed Kite is a rare species which is likely to turn up at unexpected times and places. For instance, Ashby collected a bird at Blackwood, near Adelaide, in October, 1919, and the few specimens contained in

museums have been taken from such widely separated localities as Pubelup and Broome Hill, Western Australia, Trangie (north-west of Narromine), and Sydney, New South Wales, and Gayndah (west of Maryborough), Cooktown and Cape York, Queensland.

The type of *westraliensis* is in rather abraded and soiled plumage, but so far as can be judged it does not differ from specimens from Queensland in the American Museum. The type is rather a small specimen, but one of the Queensland males has the wing only three millimetres longer.

At present there is no evidence of geographical variation. A male in the South Australian Museum, from Pubelup, collected by the late Major H. M. Whittell on December 30th, 1938, is a juvenal. It is a more "golden" bird than all others seen and entirely lacks the broad blackish stripes on the breast and head, thin blackish shafts on the feathers being the only indication of striping, with a few small black streaks on the nape. The rump is whitish, recalling the Swamp Harrier (*Circus approximans*). In this bird the iris was "grey-brown," cere "flesh colour," and feet "white."

In adults the irides have been recorded as "yellow," as also are the cere, legs and feet; the bill is bluish horn.

Wing. ♂ south-western Australia 445, 470 (SAM; HLW); 455 (*westraliensis*).
♀ 470 (HLW).
♂ New South Wales 450, 460 (HLW).
♀ South Australia 475 (SAM).
♀ Cape York 470 (SAM); eastern Queensland 490 (AM).
♂ Queensland 463, 462, 460, 466, 482 (?—shot from nest—may be mis-sexed); ♀ 480; unsexed, 465 (AMNH).

Genus HAMIROSTRA Brown 1846.

Type. *Hamirostra montana* = *Buteo melanosternon*. Australian mainland (one species).

The systematic position of this monotypic genus is still uncertain, but it may be related to the Kite *Lophoictinia*. The legs and feet are strong, the tarus heavy, feathered one-third in front and reticulated, but with a single row of scales in front somewhat larger. In its actions and posture it is unlike any other medium-sized Australian hawk, and rather resembles the Buteos or "Buzzards" in its habit of soaring in wide circles often to great heights, with separated primaries or "fingers." Like a Buteo, too, its flight is rather laboured, becoming swift on attacking when it grapples with its prey on the ground.

Although McGilp (1934) and Serventy and Whittell (1951) have stated that *Hamirostra* does not feed on carrion, perusal of various authors quoted by Mathews can leave no doubt that it does so at times. One of the specimens in Mathews' collection had, according to the collector, J. P. Rogers, fed upon a decomposed kangaroo. A similar habit has occasionally been reported in the Common Buzzard (*Buteo buteo*) of the Palaearctic Region. Despite all these resemblances to buzzards it is considered that *Hamirostra* must be regarded as a kite, and it is unfortunate that the name "buzzard" has become firmly established amongst ornithologists in Australia. It is suggested that the bird be known as the Black-breasted Buzzard-Kite.

HAMIROSTRA MELANOSTERNON (Gould).

Buteo melanosternon Gould 1841, Proc. Zool. Soc., London, 1840, p. 162; interior of New South Wales.

Hamirostra montana Brown 1846, Illustr. Gen. Bds., part 8, p. 12; Swan River, Western Australia.

Gypoictinia melanosterna decepta Mathews 1912, Nov. Zool., 18, p. 250; Parry's Creek, north-western Australia. Type: AMNH No. 532147; female; February 4th, 1909; J. P. Rogers collector. Wing, 447. Coloured plate of type: Mathews, Bds. Austr., 5, plate 248, opp. p. 188.

Range. The northern and interior regions of the Australian mainland.

This short-tailed raptorial bird is a rare species judging by the limited number of specimens in collections. It is generally accepted that a light and dark phase occurs, but we have seen no very young birds with characters of the dark phase. In the Mathews collection there are three skins from the Northern Territory and four from north-western Australia. All of them lack the black head and breast from which the species takes its name, but all appear to be adults and at least one of them was taken at the nest. They are rather uniform, although great individual variation was observed in specimens in other Australian collections. In some light phase birds the dorsal surface may be more rufous than in others, while in certain dark phase examples the hind-neck is deep rufous and there is also much rufous on the back. Other dark birds lack entirely any rufous colouration above, and the presence of this feature is probably a sign of immaturity.

Light phase specimens have been examined from Marngoe Creek, W. Kimberley, Point Torment, north-west Australia, Alexandra, Northern Territory (nesting) (AMNH), Northern Territory, Parry's Creek, Western Australia, and Byrock (HLW) and Clare (SAM), New South Wales, while the dark phase

has been taken in Western Australia (no exact locality (AM)), at Borroloola (HLW), Northern Territory, Sedan (SAM) and Cooktown (AM), Queensland, Mossgiel (AM), New South Wales, and Swan Hill (NMM), Victoria.

Wing. ♂ Western Australia 455 (AM).
♂ North Queensland 445 (AM).
♂ New South Wales 460 + (HLW), 452 (SAM).
♀ type of *decepta* 447 (AMNH).
♀ Northern Territory 455 (HLW).
♀ New South Wales 477 (AM).
♀ North Queensland 462 (SAM).

The nestling has been described as "clothed in bluish-white down with a few rufous feathers on the head and back . . . . bill horn-colour, the legs and cere pinkish-grey, and the irides brown." (McGilp, 1934.)

There is a chick labelled "about one month old" in the Australian Museum which was collected at Mossgiel, New South Wales, by K. H. Bennett, in November, 1884, which is covered with white down, with rufous feathers just appearing on the head, hind-neck, scapulars, and with the remiges and rectrices just showing, and the irides are recorded as "clear light brown," cere "bluish," legs and feet "white," and claws "black."

Two nestlings in the Australian Museum, collected at Mossgiel, New South Wales, in December, are labelled "about six weeks old." Both birds are feathered and bright rufous generally; on the under-surfaces the very bright rufous feathers of the foreneck and breast have dark shafts which are less prominent on the abdomen. Above both birds are blackish on the back, but the remainder of the bright rufous feathers all show dark shafts, including the scapulars, rump and upper tail coverts. From above the tail is brownish-grey, tipped with buffy white. "Iris, clear light brown; cere bluish-white; bill, basal half of upper mandible bluish, remainder black; lower mandible bluish; legs and feet white with black claws."

In the adult the iris is "rich hazel"; cere "greenish-white"; bill "horn colour with black tip"; legs and feet "pinkish" with "black" claws.

Genus HALIASTUR Selby 1840.

Type. *Haliastur pondicerianus* = *Falco indus*. Synonym *Ictiniastur* Mathews, 1915. Malaysia and Australasia (two species).

The name, *Ictiniastur*, was originally introduced by Mathews as a subgenus for the species *sphenurus*, but cannot be upheld.

HALIASTUR SPHENURUS (Vieillot).

Milvus sphenurus Vieillot, 1818, Nouv. Dict. d'Hist. Nat., 20, p. 564; "Australasie" = New South Wales.

Haliastur sphenurus territori Mathews 1912, Austral Av. Rec., 1, p. 88; Daly River, Northern Territory. Type: AMNH No. 532299; adult male; September 24, 1894; Knut Dahl. Wing, 379?; tail, 245? (badly worn).

Haliastur sphenurus johannae Brasil, January 7, 1916, *Rev. Franc. d'Orn.*, 4, p. 201; New Caledonia.

Haliastur sphenurus sarasini Mathews, February 29, 1916; Bds. Australia, 5, p. 169; New Caledonia. Mathews designated no type. His collection contains only one specimen from New Caledonia, a female taken November 18, 1914, by P. D. Montague, now AMNH No. 532341. This might be considered the type; on the other hand, it cannot be proved to be such, and it is possible that Mathews, who had a habit of writing new names on labels attached to specimens, examined other New Caledonian material. A search of collections, such as those of the British Museum, may reveal a specimen so labelled.

Range. New Caledonia, New Guinea, Australia; (?) visiting northern Tasmania.

Amadon (1941) revised this species and admitted no races. Re-examination of large series from Australia and New Guinea and of three from New Caledonia re-affirms this conclusion. Admittedly, some specimens from southern Australia are very large, but this is not true of all of them, and the slight size cline does not seem worthy of subspecific status. There seems to be no important colour variation. The newly moulted feathers fade and bleach more rapidly in Australia than in the more humid climate of New Guinea, but any slight difference visible in series seems to be due to this cause and not to geographic variation.

The following data for three females collected by L. Macmillan are of interest: adult, New Caledonia, May 15, 1939; wing, 415; weight, 921 grammes (fat). Adult, southern Queensland, March 25, 1940; wing, 425; weight, 761 grammes; immature (on wing), April 6, 1940; wing, 403; weight, 517 grammes.

The name "Whistling Eagle" is a misnomer, and we feel consideration should be given to the suggestion that this species be called the "Whistling Kite," especially as the birds often gather in large numbers, are kite-like in their actions, and are, in fact, kites!

HALIASTUR INDUS (Boddaert).

Haliastur indus girrenera (Vieillot).

Haliaetus girrenera Vieillot, 1822, Gal. Ois., 1, p. 31, pl. 10; "India, Bengal, Pondicherry, Coromandel and Malabar, also New Holland according to Latham." The type locality has been restricted to Australia[1], and more specifically New South Wales, as the plate is said to represent the Australian form. The species occurs in New South Wales, though we have seen no specimens from there. Stresemann (1951) has shown that the "Expedition Baudin," which secured the Australian birds named by Vieillot, collected only a limited number of species in New South Wales. He does not mention this species, but the problem is less important in that only one race is found in Australia.

Haliastur indus subleucosternus Mathews, 1912, *Nov. Zool.*, 18, p. 249; Augustus Island, north-western Australia (published as "Derby" in original description). Type: AMNH No. 532273; adult female; August 4, 1910; G. F. Hill. Wing, 372; tail 200 (?).

Range. Australia, chiefly the northern, mangrove-bordered coasts, and reaching northern New South Wales, which has been designated as type locality, but from whence we have seen no specimens. Also Papuan region and Moluccas, intergrading with *intermedius* on islands to the west of New Guinea, and extending eastwards to the Bismarck Archipelago. Normally a coastal species in northern Australia, it will often proceed far inland along the margins of rivers.

Diagnosis. Differs from *H. i. indus* and *H. i. intermedius* by having the breast usually immaculate white (without black shaft streaks). Differs from the Solomon Islands population as noted under the description of the following race.

The nominate race of the Brahminy Kite, which is confined to south-east Asia (India, Burma, southern China, etc.), is replaced in southern Annam, northern Siam and the Malay Archipelago east to Celebes and the Lesser Sundas by the race *intermedius*.

Although New Guinea birds appear a little smaller than Australian ones, the difference is hardly as great as the wing measurements suggest. Many of the New Guinea specimens are moulting or in poor feather, and it is suspected that some may be wrongly sexed.

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[1]Rothschild and Hartert, Nov. Zool., 21, p. 210, 1914.

Wing. Australia, 7 ♂, 358-377 (368); 3 ♀ 367, 372, 378; 2 labelled "♂," 378, 390 (AMNH).
Northern Territory, ♂, 343 (SAM).
North-western Australia, ♀, 375 (SAM).
Cape York, ♀, 358 (SAM).
New Guinea (and coastal islands), 15 ♂, 348-378 (359); 10 ♀, 353-373 (364) (AMNH).
New Ireland (no sex), 360 (SAM).

HALIASTUR INDUS FLAVIROSTRIS, subsp. nov.

Type. AMNH No. 221221; adult female; Bougainville Island, Solomons; April 17, 1928; Whitney South Seas Expedition. Wing, 383; tail, 207; culmen from cere, 30; depth of bill at front margin of cere, 20.

Range. Solomon Islands (including Nissan Island), also some of the easternmost islands of the Bismarck Archipelago, and Feni Island, east of southern New Ireland.

Diagnosis. Agrees with *girrenera* of Australia and Papua in having the breast usually immaculate white. Differs from it, and from the other races of the species, by having (adults) the bill entirely yellow, without blackish areas at the base of either mandible. The bill of *flavirostris* is also, when compared with that of *girrenera,* perceptibly heavier and more "aquiline."

This race is doubtless of very general occurrence throughout the Solomons. Specimens were examined from the following islands in this archipelago: Arnarvon, Bagga, Beagle, Bougainville, Choiseul, Gizo, Gower, Gaudalcanal, Kulambangra, Pavuvu, Shortland, Ugi, Vella Lavella, Wickam Arch, Ysabel.

Although specimens from the Admiralty Islands, New Britain, New Hanover, Lihir, Squally Island, and even New Ireland (one skin) are very close to or inseparable from *girrenera,* four birds from Feni Island definitely belong to *flavirostris.* Whether this Solomons' race has, correlated with its heavier bill, more predatory habits than other Brahminy Kites is not known. If so, it would form an interesting parallel to the sea-eagles represented in the Solomons by the species *Haliaëtus sanfordi,* which has more predatory habits than *leucogaster* (Mayr, 1936, p. 3).

Flavirostris averages larger than *girrenera* from Papua, but we have not enough Australian birds in good feather to be sure how they compare with *flavirostris* in size. Two unsexed Australian birds in the American Museum are fully as large as any of the Solomon Island ones, while two females in the South Australian Museum, one from the Northern Territory and one from Cape York, are slightly smaller and larger respectively than the type of this new race.

The belly in *flavirostris* averages paler rufous than in *girrenera*. While the difference is unmistakable in our material, the difference may possibly be due to wear or bleaching. No difference in colour was visible in dorsal aspect, nor did comparison of immature stages reveal colour differences.

A female was selected as type of *flavirostris* because the heavy bill is often more apparent in this, the larger sex. The colour of the bill of this race, as noted by the collectors, was usually given as "yellow," once as "chrome yellow," once as "horn with a yellow tinge," and once as "green." In the dried skin "horn with a yellow tinge" might be the best description.

Although females of this species are somewhat larger than males, it is not always possible to sex specimens accurately by measurements. The following data doubtless include some mis-sexed birds.

Wing. Solomon Islands, 16 ♂, 357-384 (371); 13 ♀, 371-390 (379).
Feni Islands, 2 ♂, 372, 373; 2 ♀, 378, 383.

Dr. E. Mayr, while with the Whitney Expedition in the Solomons, obtained the weights of three adult males, as follow: 625, 625, 650 grammes.

Genus ACCIPITER Brisson 1760.

Type. *Accipiter* Brisson = *Falco nisus* Linné. Synonyms include *Astur* Lacépède 1799, *Leucospiza* Kaup 1844, *Urospiza* Kaup 1854, and *Paraspizias* Mathews 1915. Old and New Worlds (about 45 species).

All the generic synonyms given above were used at some time or other by Mathews in his various writings; none can be upheld. There are no reliable characters available for separating the goshawks (under *Astur*) from *Accipiter* (cf. Peters (1931), p. 205, footnote).

Owing to variation in size, plumage, coloration and pattern, some confusion has occurred as to the number of Australian species which should be admitted. Gould (1865), Sharpe (1874, 1899), North (1912) and Mathews (1946) all regarded the "Grey" and "White" Goshawks as separate species, but there seems little doubt that these are merely colour phases of a single species, *Accipiter novaehollandiae*.

Accipiter fasciatus and *A. cirrhocephalus* are sibling species which almost defy exact definition on a physical basis apart from size; both pass through similar plumage stages, but the changes are more prolonged in the first-named. In birds from the extreme north of Australia, males of the former are about the same size and colour as females of the latter, and mis-sexed cabinet specimens may add to the confusion. In southern birds, small males of *fasciatus* also provide some difficulties. Perhaps the most reliable feature for separating the

two species is the bill, which in the larger is always noticeably heavier. Measurements of the greater height of the maxilla or upper mandible have shown that in *didimus,* the northern race of *fasciatus,* this is about 10 mm., while in females of *cirrhocephalus* it rarely exceeds 8·5 mm. In the cabinet skin the feet may dry in such a way as to make measurement difficult, but it is usually quite apparent that the tip of the hind claw reaches only to the proximal end of the last segment of the middle toe in the Collared Sparrowhawk, whereas in *fasciatus* it reaches to the base of the claw of the middle toe. Nevertheless, in the Brown Goshawk the condition is more variable, and in some birds the tip of the hind claw only reaches to about the middle of the middle toe. Because of these differences in the toes *fasciatus* was finally placed in *Astur* with the goshawks.

Slight differences in the barrings of the primaries may also be observed. In *cirrhocephalus* the dark barrings are usually wider and stronger at all stages, whereas in *fasciatus* they may be narrow and tapering, with the outer edge of the feather light-coloured, and the bars not extending so far towards the tip of the wing. Exceptions in both species occur.

In young birds, differences in the tarsal scutes permit ready separation of the species. In *cirrhocephalus,* which moults directly into adult plumage from the juvenal stage, the scutes are fused at quite an early age, but in *fasciatus* the "booted" condition is found only in old birds.

Much confusion has occurred regarding the status of the problematical "West Australian Goshawk," *A. cruentus* of Gould and other early writers, but we have been unable to discover any discernible basis for its recognition, either as a species, "hybrid," or geographical race. Gould's type specimen, which came from the York district, Western Australia, appears to have been merely a rather small individual in fully adult plumage (cf. Ramsay 1879, p. 174; Gurney 1881, p. 262). North (1898, p. 16-18; 1912, p. 194) dealt at some length with "*cruentus,*" and referred to it as "undoubtedly the rarest" of Australian Accipitres, but examination of specimens in the Australian Museum labelled as such (by Ramsay or North) has shown that they are typical *didimus.*

Mathews, who examined the type of *cruentus,* found that North's "*cruentus*" was not the same as Gould's bird, but "the common bird of Western Australia" (i.e., *fasciatus*) (quoted by White, 1915).

ACCIPITER FASCIATUS (Vigors and Horsfield).

Accipiter fasciatus fasciatus (Vigors and Horsfield).

Astur Fasciatus Vigors and Horsfield, 1827, Trans. Linn. Soc. London, 15, p. 181; New South Wales.

Astur cruentus Gould, 1842 (1843), Proc. Zool. Soc. London, p. 113; York district, Western Australia. Type said to be in the Academy of Natural Sciences of Philadelphia (No. 1279).

Astur maculosus Coles, 1897, Vict. Nat., 14, p. 43; Blackburn, Victoria. (Type said to be in British Museum.)

Astur fasciatus mackayi Mathews, 1912, Nov. Zool., 18, p. 246; Mackay, Queensland. Type: AMNH No. 533214; adult male. The specimen has no date, locality, or field label, but according to Mathews' catalogue was acquired in 1911 from the London dealer, Gerrard. Wing, 290? (worn moulting); tail, 237? (worn). The type is in excessively worn plumage; this is the basis for this supposedly brown-backed race.

Urospiza fasciata rennelliana Kinghorn, 1937, Proc. Zool. Soc. London, ser. B, 107, part 1, p. 180; Rennell Island. Type: Austr. Museum No. O 32284. The specimen has no date or field label, but bears a printed label "Astur versicolor Ramsay. Hab. Ugi Isld. Sex female." The entry in the Australian Museum Register merely states "Rennell Island. Coll. G. A. V. Stanley." Wing, 280; tail, 214; tarsus 75. The type is in very poor condition and the plumage is badly faded and worn.

Range. The whole of Australia, except the coastal northern regions from Cape York westwards to the Kimberleys; Tasmania; Norfolk Island (queried by Peters, 1931, no specimens seen by us); Rennell and Bellona Islands, off the southern Solomons.

The Brown Goshawk occurs in all parts of Australia and Tasmania, and has a wide distribution in tropical regions from Christmas Island in the Indian Ocean through the Lesser Sundas and Timor to New Guinea, New Caledonia, Lifu, Loyalty Islands, and Fiji eastwards. Peters (1931) listed seven subspecies, including three from Australia, and Rand (1941) has described an additional New Guinea race, *dogwa*.

Peters used the name *cruentus* for birds from "West and South Australia," perhaps following Mathews, but there is little justification for recognizing a dry country race even though birds from a wide area over the interior of the continent are duller and with greyish heads, characters which seem to be largely induced by wear and fading. Examples from more humid regions have blackish heads, and we have seen specimens from Napier Broome Bay, north-western Australia, Vasse, south-west Australia, Adelaide, South Australia, Heidelberg, Victoria, and Ravenshoe, north Queensland, which are inseparable from New South Wales birds. In several south-western individuals in the Australian Museum the thighs were brighter rufous than in eastern ones both in the adult

and young, but generally speaking western birds seem to be practically indistinguishable.

Although nothing is known of regular movements of the Brown Goshawk in Australia, specimens examined suggested that, in Western Australia at least, southern birds may wander to the extreme north of that State, thereby invading the territory of *didimus*. An adult female in the National Museum, Melbourne, collected on June 5, 1910, at Napier Broome Bay is fully as large as and almost indistinguishable from dark-headed birds from Vasse (near Busselton), Western Australia, Plenty River (near Melbourne), Victoria, and Cobborah, New South Wales. Furthermore, during a recent Australian Museum expedition, Mr. Allen Keast collected a large female (wing 290), in juvenal plumage, at Forrest River Mission, about 50 miles south of Napier Broome Bay, on June 2, 1952. Two other juvenals in the Australian Museum (no dates recorded), and one in the South Australian Museum (female, April 8, 1913) were taken near Derby, north-western Australia, and all are large birds. Although more brownish above and below than examples of corresponding age seen from the south, they are matched by at least one from Homebush, New South Wales, and several from Swan River and King George's Sound, Western Australia. The breast and foreneck are heavily-barred brown, the whitish throat is heavily streaked with brown, and the thighs are dull rufous-brown and buffy white.

Tasmanian birds are generally somewhat larger, a little darker above and below, with more whitish throats than most from the adjacent mainland. However, at this stage, we prefer not to introduce a name to indicate the differences in this population, which appears to merge with southern mainland birds.

It is remarkable that on Rennell Island and its outlier, Bellona Island, there is a population of this species very similar to the New Caledonian (*vigilax*) and Australian races. Rennell, though usually included with the Solomons, is considerably south of that group and has a somewhat different fauna, and *Accipiter fasciatus* does not occur in the Solomons proper.

The Whitney Expedition secured a pair of adults of *fasciatus*, the male in badly worn plumage, on Rennell and Bellona. This was before the American Museum had any specimens of *vigilax*, and Mayr, in his report on the Rennell Expedition (1931), based his assignment of these birds to *vigilax* on a comparison made for him in the British Museum by the late A. Goodson, who noted their similarity to *fasciatus* of Australia.

With the present fine series of *vigilax*, it became evident that the pair of adults from Rennell is larger in every dimension than *vigilax*. The difference is not very great, however, and merely serves to bring the Rennell birds into the size class of *f. fasciatus*, from which they appear inseparable. In particular,

the adult male from Bellona, which is in fine plumage, agrees in every detail of colour and size with specimens from southern Australia.

In the meanwhile, a third specimen was collected on Rennell by G. A. V. Stanley, and became the type of Kinghorn's *Urospiza fasciata rennelliana*, differentiated as follows: "In size and colour this bird is very similar to the narrow-banded form of *U. fasciata*. The tail feathers, though much worn at the tips, are a little broader than those of *U. fasciata* (Australian), the tarsus is longer, and the legs and feet more powerfully built . . . . Wing, 280." These differences are not apparent in the two birds in the American Museum. Examination of the type of *rennelliana* in the Australian Museum confirms Kinghorn's remarks to some extent, but the differences are well within the range of variation met with in Australian birds, and the specimen is in poor condition. It appears to be rather faded, with a "washed-out" appearance, and in this respect is similar to a specimen of *didimus* from Darwin. The head is dark grey, the face pale brownish-grey, and there is a trace of a red collar on the sides of the neck; the upper surfaces are greyish-brown. Ventrally, the feathers are barred pale rufous and dull white (slightly wider and darker on the breast), and the thighs are of the same colour.

Unless by chance the Rennell birds reached there rather recently from Australia, one would not expect them to be the same as the Australian race. We conclude, nevertheless, that *rennellianus* must be considered a synonym of *fasciatus* until proved otherwise.

A few very large examples (mainly females) were examined from New South Wales and Tasmania, but the size is not indicated by wing or other conventional measurements. Nevertheless, even allowing for different methods of preparation resulting in some distortion, it is believed that outsize birds (and also "runts") may be met with occasionally.

Except where otherwise indicated, measurements given below are taken from skins in museums in Australia.

Wing. ♂, adult.

South-eastern Australia (6), 260-275 (265) (AMNH).
New South Wales (9), 255-278 (265).
Victoria (1), 270.
Tasmania (4), 268-272 (270·5).
South Australia (7), 256-270 (262).
Southern Queensland (1), 268 (AMNH).
South- and mid-west Australia (3), 250 +, 261, 262 (AMNH).
Rennell Island (1), 265 (AMNH).

♂, immature (8), 257-267 (262) (AMNH).

♂, second year
New South Wales (7), 247-270 (260·1).
Tasmania (1), 270.
South Australia (4), 255-270 (261·5).
Southern Queensland (1), 270.
South-west Australia (1), 266.

♂, juvenal
New South Wales (7), 245-275 (264·4).
Tasmania (1), 264.
South Australia (16), 227-270 (261·7).
South-west Australia (4), 238-265 (253·7).

♀, adult
South-eastern Australia (3), 302, 307, 311 (AMNH).
New South Wales (3), 302, 305, 310.
South Australia (3), 300, 302, 308.
Southern Queensland (1), 312 (AMNH).
South-west Australia (1), 305.
South-west and mid-west Australia (3), 300, 305, 313 (AMNH).
North-western Australia (1), 290.
Northern Territory (2), 287, 305.
Rennell Island (2), 280 (AM), 292 (AMNH).

♀, immature (15), 295-312 (304) (AMNH).

♀, second year
New South Wales (8), 292-311 (298·8).
South Australia (8), 265-305 (290·2).
North Queensland (1), 305.

♀, juvenal
New South Wales (6), 296-312 (304).
South Australia (10), 262-311 (300·6).
Tasmania (7), 291-305 (300·7).
South-west Australia (4), 253-290 (268·2).
North-western Australia (4), 270-290 (279·5).

Weight, 1 large ♀ imm. 593 grammes.

Altogether, we have examined and measured more than 170 specimens of this, the large, more heavily-pigmented nominate race. The general trend towards maturity is for the broad stripes and barrings of the ventral surface in the juvenal to be replaced by narrower transverse barrings, probably over a period

of several years. Immature birds far outnumber adults in collections, and this has enabled us to distinguish three plumage stages—juvenal, "second year," and adult. Individuals in fresh plumage are always darker than those in worn plumage, especially on the upper surfaces. The moult from one plumage stage to another is gradual and protracted, and is responsible for the remarkable variety of patterns met with. However, most of the variations in colour are due to wear and fading, and very few skins were seen in which it was due solely to moulting. This is remarkable considering the large number of individuals handled.

After hatching, in the late spring or early summer, the white downy chick rapidly acquires the juvenal plumage—first on the wings, then on the scapulars, back and tail. As soon as fully fledged, and when about a month old, the young Goshawk leaves the nest.

Juvenals of both sexes, which differ markedly from adults, may be distinguished by the heavy brown streaks on the breast and throat and the broad blotches or barrings on the abdomen. Above, the dark brown feathers are edged with cinnamon-rufous, this later fading to pale buff or being lost by wear. The nape is streaked with white, the central rectrices are prominently barred above, and the tibiae are indistinctly or broadly barred dull rufous and buffy white. The few Tasmanian specimens examined have the streaks on the throat reduced, and the tibiae are heavily barred fawn and buff. Juvenals of *didimus* are duller with less rufous above (perhaps due to fading), have less white at the nape, numerous streaks on the chin and throat, and dull rufous-brown tibiae with only slight indications of barring.

It is believed that the juvenal plumage is retained for nearly one year, when the "second year" plumage is gradually acquired. The first new feathers are those of the crown, cheeks, mantle, throat and abdomen, and these are fully developed before the second summer; the tail may not be replaced completely until the beginning of the following autumn.

The "second year" plumage is much like the adult, but may be distinguished as follows. The upper surfaces are dark greyish-brown without any rufous and the crown is blackish-brown or dark grey with fewer white streaks at the nape. The only trace of a chestnut nuchal collar is on the sides of the neck, while the central rectrices are paler and more distinctly barred than in the adult and are the last feathers to be acquired. Below are numerous transverse bars on the breast, abdomen and under tail coverts of dull rufous brown with darker edges adjacent to the alternating white bars; the throat is dappled grey and dull white and the tibiae have acquired narrow bars of dull rufous and white. The markings on the lining of the wings resemble the barrings of

the underparts, being rufous instead of dark brown (as in the juvenal). Individuals are commonly found breeding in this plumage.

Nothing appears to be known of the duration of the "second year" type of plumage, but it may be retained for more than one year. In most descriptions reference is made simply to "immature" and "adult" plumages, the "second year" stage being included in the last-named. There is reason to believe, however, that the fully adult bird is characterised by much finer rufous and white ventral barrings on the breast, abdomen, under tail coverts, and thighs. A prominent chestnut collar and usually the complete absence of white streaks on the nape also distinguish this stage, when the central pair of rectrices are dark in colour with the merest trace of darker barrings. Altogether, the fully adult Goshawk, examples of which are rare in collections, is a brilliantly-coloured bird when in fresh plumage. It may be recognized also by the complete fusion of the tarsal scutes, which forms the "booted" condition.

From specimens examined it would appear that the moult into adult plumage commences in the spring and continues for several months, although the body feathers are rapidly acquired.

In several adult females the iris has been variously recorded as "yellow," "bright yellow," and "dark golden"; feet "yellow"; cere "olive" or "green"; bill "blackish" or "blackish-blue." In a female juvenal the irides and feet were found to be "straw yellow."

Accipiter fasciatus didimus (Mathews).

Astur fasciatus didimus Mathews, 1912. Austral. Av. Rec., 1, p. 33; Melville Island, Northern Territory.

Range. Coastal regions from about Cooktown, Cape York, westwards to the Northern Territory and Derby, north-western Australia.

In his original diagnosis the author stated "differs from *A. f. fasciatus* in its smaller size: wing 236 mm." In addition, *didimus* is a paler bird than the other Australian race, and intergradation between the two forms seems to be of the "stepped cline" variety.

A pair of birds from as far north as Mackay, Queensland, one of them the type of Mathews' *mackayi,* are fully as large as specimens of more southern origin. Another bird, in the H. L. White collection, from Vine Creek (altitude 3,000 ft.), Ravenshoe, which is just south of Cairns, belongs to the nominate form, while a large series of birds from Cooktown are nearer *didimus* in size, but a few of them are fully as large as average examples of *f. fasciatus.* Some of the Cooktown specimens are quite as small as topotypical *didimus* from Mel-

ville Island, and do not differ in colour. The situation in north-western Australia may indicate a rather sharp area of intergradation, but the fact that a few specimens are as large and dark as *fasciatus* while others are as small as *didimus* suggests that the former may have been visitors from the south, and this has already been discussed above.

Wing. ♂, adult
Melville Island (5), 229-239 (234) (AMNH), 238 (SAM).
Northern Territory (3), 240 (AMNH), 249 (AM), 245 (HLW).
Cape York (4), 235, 240, 246 (AMNH), 247 (NMM).
North-western Australia (2), 230, 235? (AMNH).
♂, immature (22), 229-262 (247) (AMNH), 225-253 (243·3) (SAM).
♀, adult
Melville Island (2), 263?, 275 (AMNH).
Northern Territory (2), 270?, 277 (AMNH), (4), 270-287 (276) (AM).
N. Cape York (2), 270, 284 (AMNH).
Cooktown, C. York (7), 272-297 (287) (AMNH).
Derby, N.W.A., 265 (AM).
♀, immature
Melville Island (1), 261.
Northern Territory (5), 267, 268, 314? (AMNH), 254, 272 (SAM).
Normanton, Queensland (3), 272, 276, 290 (AMNH).
Cape York (29), 258-291 (277) (AMNH), (1), 285 (NMM).
New Guinea (*A. f. polycryptus* and *A. f. dogwa*)
♂, adult (4), 223, 224, 227, 233; ♀, adult (3), 254, 256, 257.

Most of the races of *fasciatus* of New Guinea and the smaller islands north of Australia are more or less similar to *didimus*, but, for the most part, even smaller, paler, more rufous, and in some cases actually whitish on the flanks and belly (e.g., *hellmayri* Stresemann, *dogwa* Rand).

Accipiter fasciatus buruensis Stresemann.

Accipiter torquatus buruensis Stresemann, 1914, Nov. Zool., 21, p. 381; Fakal, Buru.

Range. Island of Buru.

The status of this race is puzzling[2]. Stresemann said it does not differ from *fasciatus* in colour, but is smaller. He gave wing lengths as 259 and 270.

[2]See also Van Bemmel, Treubia, 19, 1948, part 2, p. 392.

The smaller of these, the type, which is the only one we have available for comparison, actually has the wing in moult. Stresemann did not mention the small north Australian race *didimus,* a valid form which Mathews had described two years before. Direct comparison of the type of *buruensis* with topotypical females of *didimus* reveals no appreciable difference. The bill of *buruensis* seems a bit heavier (and perhaps the feet also); it is slightly greyer on the chest than most *didimus,* thus resembling *f. fasciatus* rather than *didimus.* Were Buru adjacent to north Australia we should not hesitate to list *buruensis* as a synonym of *didimus.*

Buru is some distance removed, however, and distinct races inhabit the islands around it, including a small rufous race *wallacii* found on some of the smaller islands more or less intermediate in geographical position between Buru and Australia. It is not expected, therefore, that the birds of Buru will belong to the northern Australian race, and until proved otherwise by adequate material, it must be assumed that *buruensis* is valid on the basis of slight differences noticed and perhaps additional ones that will become evident in series.

Accipiter fasciatus vigilax (Wetmore).

Astur fasciatus vigilax Wetmore, 1926. Condor, 28, p. 6 (new name for *insularis* Sarasin, pre-occupied); New Caledonia.

Like *tjendanae* of the island of Sumba, this race is similar in colour to nominate *fasciatus,* but smaller. Mr. L. Macmillan collected a fine series of this bird for the American Museum on New Caledonia (the type locality) and on the three principal islands, Lifu, Mare, and Uvea, in the Loyalty Group. They all belong to *vigilax,* in which the bars on the underparts are rather greyish, as in *fasciatus,* except the flanks, which tend to be more rufous as in *didimus.*

Wing. ♂, adult (9), 236-253 (244); ♀, adult (5), 263-282 (275).

ACCIPITER CIRRHOCEPHALUS (Vieillot).

Accipiter cirrhocephalus cirrhocephalus (Vieillot).

Sparvius cirrhocephalus Vieillot, 1817, Nouv. Dict. d'Hist. Nat., 10, p. 329; New South Wales.

Accipiter cirrhocephalus broomei Mathews, 1912, Nov. Zool., 18, p. 247; Broome Hill, southern Western Australia. Type: AMNH No. 533982; adult male; "8/6/6" (? June 8, 1906); "T.C." (? Tom Carter). Wing, 205; tail, 150.

Range. Tasmania; Australian mainland, except the northernmost parts.

Four races[3] of the Collared Sparrowhawk may be recognised; *papuanus* (New Guinea) and *quaesitandus* (northern Australia) are smaller and more rufous ventrally than *cirrhocephalus,* while *rosselianus* (Rossel Is., New Guinea)[4] is believed to be large and similar to the nominate form but darker above, though less heavily marked below.

Of "*broomei,*" Mathews stated, " . . . . darker above and the nuchal collar darker red," but we have seen examples in the Australian Museum from south-western Australia which are inseparable from eastern Australian birds, including Tasmanian ones. Nevertheless, the darker colorations which characterize the nominate race are on the whole slightly more evident in the west, though most specimens from the two areas cannot be differentiated.

Colour variation in *Accipiter cirrhocephalus* in Australia parallels that in *Accipiter fasciatus*; northern birds are paler, more rufous, and in both species these trends are continued further in New Guinea. In the case of *fasciatus,* most of the other races of the northern islands are also paler and more rufous than the Australian forms, but there are also definite exceptions; *cirrhocephalus* is absent from these smaller islands.

As regards size variation within Australia, *fasciatus* is much smaller in northernmost Australia than in southern Australia, while *cirrhocephalus* is only slightly so. The two species can be confused in the north, if the two sexes are not kept separate, but hardly in the south.

Wing. 10 ♂, 200-219 (208); 8 ♀, 232-242 (238) (AMNH).
15 ad. ♂, 195-210 (205); 14 ad. ♀, 232-251 (236·5) (AM, NMM, SAM).

Although *cirrhocephalus* is very similar to *A. fasciatus* in plumage, the change from juvenal to adult is direct and takes place at the beginning of the second year; this is indicated in examples with the fine breast barrings of the adult intermixed with the heavy blotches or stripes of the juvenal. Juvenals of the two Australian races are inseparable.

Accipiter cirrhocephalus quaesitandus Mathews.

Accipiter cirrhocephalus quaesitandus Mathews, 1915. Birds of Australia, 5, p. 81; Utingu, Cape York, Queensland. Type: AMNH No. 533939; adult male; July 4, 1912; Robin Kemp. Wing, 203; tail, 154.

Accipiter cirrhocephalus haesitata Mathews, 1917. Austral Av. Rec., 3, p. 128; Cape York.

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[3]Van Bemmel, 1948, Treubia, 19, p. 391, also regards *Accipiter erythrauchen* of the Moluccas as conspecific with *cirrhocephalus.*

[4]Mayr, 1940, Amer. Mus. Novit., 1056, p. 12.

Type. No skin indicated as the type of this race is present in the American Museum of Natural History; probably no type was designated. Although entered as a new race, with description and type locality, one wonders about the connection of *haesitata* Mathews, 1917 to *quaesitandus* Mathews 1915 with the same type locality. Probably in 1917 Mathews forgot that he had named the Cape York population in 1915, and yet involuntarily picked a similar sounding name. Perhaps he realized the blunder later and for this reason did not designate a type for *haesitata*.

Range. Cape York and the entire north coast area of Australia.

Diagnosis. Differs from *c. cirrhocephalus* by being less greyish, more rufous ventrally and perhaps slightly smaller. The race *papuanus*, of New Guinea, is still more rufous ventrally, and less barred; it also smaller (wing, ♂, 184).

A male from Normanton and one for north-western Australia are slightly paler than the other four adult males, all from Cape York, in the American Museum. It is probable, however, that the differences observed are due to individual variation and, in part, to plumage fading in the arid regions, because several other skins do not show this difference. Specimens of this race have been examined from Mt. Alexander (south of Derby), Fitzroy River, Brooking Creek (West Kimberley); Borroloola, Brock's Creek, Alexandra, Alligator River, Groote, Melville and Bathurst Islands (all Northern Territory).

It is probable that birds from the arid portions of the interior and Western Australia begin to show the paler, rufous coloration of *quaesitandus* at more southern localities than do those from the humid eastern coast. Yet, an adult female, taken in 1947 by Ken Buller on the De Grey River, well north in mid-western Australia, is typical of the nominate race. This bird weighed 235 grammes.

Wing. 6 ♂, 196-209 (201); 4 ♀, 229-237 (232) (AMNH).
2 ad. ♂, 194 (HLW), 200 (SAM); 6 ♀, ad. 228-242 (235·5) (HLW, SAM).

ACCIPITER NOVAEHOLLANDIAE (Gmelin).

Accipiter novaehollandiae novaehollandiae (Gmelin).

Falco novae-Hollandiae Gmelin, 1788, Syst. Nat., vol. 1, pt. 1, p. 264; New South Wales ex Latham = Tasmania fide Mathews.

Astur clarus cooktowni Mathews, 1912, Nov. Zool., 18, p. 245; Cooktown, northern Queensland. Type: AMNH No. 532939; "♀" = adult male, grey phase; May 13, 1902 (E. Olive). Wing, 261; tail, 197. As Hartert already pointed out, this bird is obviously a male and Mathews' indication of its smaller size as compared with a female from New South Wales is not significant.

Astur novaehollandiae alboides Mathews, 1912, Nov. Zool., 18, p. 246; Parry's Creek, East Kimberley, north-western Australia. Type: AMNH No. 532958; adult male, white phase; October 8, 1908; J. P. Rogers. Wing, 258; tail, 194.

Astur clarus robustus Zietz, 1914, South Aust. Ornith., 1, p. 13; Melville Island, Northern Territory. Type: SAM No. B1334; female, juv., grey phase; August 2, 1913; W. D. Dodd, collector. Wing, 285; tarsus, 79; tail, 220. "Iris yellow, feet yellow."

Range. Tasmania (white phase only); Australia (chiefly eastern and northern); Kangaroo Island.

The Grey and White Goshawks of Australia are now known to be phases of one and the same species (see also Mack, 1953). Somewhat more difficult for immediate acceptance was Stresemann's demonstration that the brown (*"etorques"*) and white (*leucosomus*) birds of New Guinea are also phases. "Wild-type" birds of Australia are white below, barred with grey on the breast and pale grey above; in New Guinea races they are dark grey above and rufous or deep chestnut below. The female of the race *leucosomus* is somewhat barred, so that by a total loss of the phaeomelanins and a loss in intensity of the eumelanins, a coloration like that of wild-type Australian birds could result. Such changes, in one direction or another, have been of not infrequent occurrence during the evolution of the numerous species and races of raptorial birds of the Australo-Papuan region, many of which are grey and white, others grey and rufous.

Mayr has pointed out that immatures of wild-type *leucosomus* vary greatly in the amount of phaeomelanins present. Some of them are as light (though more heavily marked) as immature wild-type *novaehollandiae*. He designated two phases of these *leucosomus* wild-type immatures: a "rufous" and a "white" one. The latter might better be termed "pale," since it apparently, as Mayr concluded, has nothing to do with the true white phase of *leucosomus*. We are inclined to believe that this variation in immature wild-type *leucosomus* may, to a greater degree than realized by Mayr, be due to bleaching, fading, and possibly to age changes (appearance of first indications of adult rufous coloration), but there is undoubtedly some genuine genetic variation in the amount of phaeomelanins present. This helps to explain how, in wild-type *novaehollandiae*, the phaeomelanins are entirely lacking in all stages of plumage, and is further argument for regarding *leucosomus* as a race of the Australian bird.

It is impossible to say whether the paling of the wild-type plumage in the nominate race (adults are nearly white below and pale grey above) has any

selective relation to the occurrence or origin of the white phase. Certainly the latter is a discrete genetic entity; even immatures of the white phase birds are said to be pure white at all ages. At the same time, it is possible that the physiological advantages presumably correlated with the white, which in Tasmania have led to its complete establishment, are also present and responsible for the paling of the wild-type Australian birds. The by no means low incidence of the white phase in New Guinea in a race which the wild-type adults are dark-coloured might be considered to refute this suggestion. As already noted, however, there is a reduction of phaeomelanins (and perhaps in the intensity of eumelanins) in a considerable percentage of immatures of *leucosomus,* wild-type, so it is possible that the same trends discernible in wild-type *novaehollandiae* are incipient in *leucosomus.*

Although white plumage may have a direct selective advantage in gyrfalcons and snowy owls, one cannot suppose this to be the case in white phase *novaehollandiae.* More likely, the white colour is genetically linked with unknown favourable characters, and since it has not proved to be a great disadvantage it has become widespread. Hawks have few predators themselves, and apparently the white plumage does not seriously inconvenience them in securing their own prey. One observer even believed that small birds showed less fear of white goshawks than of the generality of hawks, perhaps mistaking the former for white cockatoos!

In the case of *novaehollandiae,* the increase in size and the change in colour is so abrupt when one passes from the northern islands to Australia, that some may still prefer to recognize two species. The occurrence of a white phase in *leucosomus* does, however, serve to link the island races with that of Australia and Tasmania. One is inclined to follow the current practice and make them all races of *novaehollandiae,* if for no other reason than to emphasize the amount of variation that can occur within the limits of a "rassenkreis."

It is worth pointing out that the race *misulae* Mayr, found on two of the small islands east of New Guinea, is almost as large as nominate *novaehollandiae*; its feet and bill are fully as robust as in the latter race. Wild-type, that is "grey phase," birds of *Accipiter novaehollandiae novaehollandiae* differ from those of all other races by lacking rufous in the adult. White phase birds are inseparable from white phase *leucosomus* of New Guinea, but are, sex for sex, much larger.

White phase birds in Australia are usually pure white at all ages and in all areas. We have discovered no geographical variation in colour in the grey phase. Fleay (1950) refers to one case of intermediacy, a specimen in the H. L. White collection. This bird is white, but with grey on the shoulders, back

and outer webs of the secondaries. It is a female taken at Dorrigo, N.S.W. In immature birds of the grey phase the bars on the breast are much broader than in the adults and they are slightly tinged with brown. Dorsally a faint brownish collar is sometimes evident, and this seems to represent the last stage in the disappearance of a rufous nuchal collar previously present, and characteristic of many species of Accipitres in their adult plumage.

As long since known, only the white phase of this hawk occurs in Tasmania. In Australia, as Southern and Serventy (1947) have shown in a detailed, if somewhat laboured, analysis, there is little regular or clinal variation. In particular, there is no regular decrease from south to north in the incidence of white birds, which, as a matter of fact, predominate in the Northern Territory, and apparently, in the adjacent Kimberley Division of north-western Australia (whence the only specimen we have seen is the type of Mathews' *alboides*). Although these colour phases are, of course, genetic, the percentage of white birds in Australia is far too high to warrant separating them racially from the all-white population of Tasmania.

Turning now to size variation, Mathews described a race *cooktowni,* from Cape York, and another race *alboides,* from the far north-west. Both supposedly differed from nominate *novaehollandiae* (*terra typica,* Tasmania) by smaller size. Mathews later admitted there is very little reason to think northern birds are smaller. Zietz, meanwhile, named a race from Melville Island which he believed to possess characters embodied in the name *robustus.* The type specimen is medium greyish-brown above, including the head, and has fairly heavy brownish barrings beneath, as well as an unbooted tarsus, both signs of immaturity. It is quite an average specimen in every way, and we conclude that Zietz must have lacked adequate comparative material at the time when he introduced the name *robustus.* Hartert (1931, pp. 40-41), in discussing Mathews' two types, admitted that they (and many other northern specimens) are as large as southern ones. He also detected a slight size decrease northerly which he thought might warrant recognition of *cooktowni* and most later writers have followed this course, including Peters (1931).

Although Fleay (1950) believes Tasmanian birds to be larger and heavier than others, we have been unable to discover any great variation in size in this hawk, in available material, and believe it to be non-existent or negligible. One has only to place side by side adults from Tasmania, Cape York and the Northern Territory to see that they are, in general terms, of the same size. It is true that, in series measurements, the northern birds average a bit smaller, but even this may be because the northern specimens available are in general in poor plumage. The interesting point is that the birds of such climatically

diverse and rather remote areas as Tasmania, Cape York and Melville Island and the Kimberley Division are substantially alike in size. The correct means of emphasizing this is, it seems to us, to unite all the Tasmanian and Australian birds in one race, *novaehollandiae.*

Wing. Tasmania: 3 ♂, 250, 254, 257 (all worn) (AMNH).
8 ♀, 295-309 (305) (AMNH).
South Australia: 1 ♀, 315 (AMNH).
1 ♀, 313 (SAM).
New South Wales: 5 ♂, 258-270 (AMNH).
2 ♀, 306, 312 (AMNH).
Queensland (except Cape York): 5 ♀, 290-319 (307) (AMNH).
Cape York: 7 ♂, 257-270 (261) (AMNH).
7 ♀, 293-300 (296) (AMNH).
Melville Island: 1 ♀, 303 (AMNH).
1 ♀, 285 (SAM) (type of *robustus*).
Northern Territory (except Melville Island): 1 ♂, 253 (AMNH).
2 ♀, 300, 304 (AMNH)
North-western Australia: 1 ♂, 258 (AMNH).

Genus ERYTHROTRIORCHIS Sharpe, 1875.

Type. *Falco radiatus.* Australian mainland (one species).

The single member of this genus is usually considered to be a modified goshawk. The wings are longer and the tail shorter than in *Accipiter,* but the feet suggest that genus, while the coloration, as Mr. M. Jollie has pointed out to us, is very like that of *Accipiter burgersi* of New Guinea.

Although *Megatriorchis doriae* of New Guinea has sometimes been included in this genus, as for example in Peter's Checklist (1931), such action is debatable to say the least. *Doriae* has departed from *Accipiter* in just the opposite way from *radiatus;* the wings are very short, the tail very long. Thus *doriae* resembles *Urotriorchis macrourus* of equatorial Africa, but the latter is not so far from typical *Accipiter.*

Erythrotriorchis radiatus is said to soar at times and is undoubtedly less closely restricted to forest cover than is *M. doriae.* Both species have very long, curved claws and both are bird-eaters. Presumably they branched off independently from *Accipiter* stock, but even if they are more closely related than this would indicate, they are now too unlike to fit properly in the same genus.

ERYTHROTRIORCHIS RADIATUS (Latham).

Falco radiatus Latham, 1801, Index Ornith., Suppl., p. xii; New South Wales.

Erythrotriorchis rufotibia Campbell, 1911, Emu, 10, p. 249; Napier Broome Bay, Kimberley Division, Western Australia. Type: National Museum, Melbourne, No. HLW 5369; adult female; June 21, 1910; G. F. Hill for H. L. White. Wing, 396; tail, 245; tarsus, 7·5. Paratype: HLW 5370; adult female; February 18, 1909; G. F. Hill. Wing, 395; tail, 235; tarsus, 8.

Erythrotriorchis radiatus katherine (sic) Mathews, 1916, Austr. Av. Rec., 3, p. 57; Katherine River, Northern Territory. Type: AMNH No. 534012; male moulting from very worn and faded plumage into adult plumage; July 25, 1895; (Knut) Dahl. Wing, 353; tail, 220. Coloured plate of type: Mathews, vol. 5, pl. 240, opp. p. 87.

Erythrotriorchis radiatus queenslandicus Mathews, 1917, Austr. Av. Rec., 3, p. 128; "Cedar Bay" (label says "Cardwell"), Queensland. Type: AMNH No. 534013; adult male (said to be from a collection made in northern Queensland in June and July, 1898, by collectors of A. S. Meek). Wing, 362; tail, 218.

Range. Australian mainland.

The Red Goshawk, which seems to occur mainly in northern and eastern Australia, is undoubtedly one of the rarest and least-known hawks, and the number of specimens in museums is limited.

Hartert (1931, p. 42) has already pointed out that Mathews' names *queenslandicus* and *katherine* are synonyms of *radiatus,* and there is no reason to believe geographical variation occurs. The type and paratype of *rufotibia* Campbell have been examined; both are females which seem to fall within the variational limits of the species. Campbell's specimens, which came from northwest Australia, differ from all others contained in the H. L. White collection in being whitish on the centre of the breast and abdomen, with the undertail coverts more whitish, but with some rufous. As the name implies, the thighs are more rufous than the underparts, but this feature is matched in an adult female from Borroloola, Northern Territory, and this specimen also has a rather whitish abdomen. The rump is variable, being grey in the type of *rufotibia,* grey with some rufous in the paratype and rufous in all others seen. While the colour of the upper surface generally is rather uniform, there is much variation in the coloration of the lower surfaces. The chin and throat varies from whitish to buff, with blackish stripes, and in a male from Cairns, taken in November, 1909, the entire underparts and tibiae are deep rufous.

All but one (the type of *katherine*) of the seven specimens in the American Museum are from Queensland. Three skins in the H. L. White collection are from Borroloola, one from Cairns, and one from King River, Northern Territory. This last-named specimen, as well as another male from Borroloola have the tail incompletely barred, a sign of immaturity. In the South Australian Museum there is a male from Bathurst Island and a subadult female from Byromine, Cloncurry River, Queensland has the tail incompletely barred.

Three adults with completely barred tails and taken at Cooktown, Junction Camp, and Dawson River, Queensland, are in the Australian Museum, Sydney. Measurements:

Wing.	♂,	335, 345, 350, 352, 353 +, 355, 356, 358, 360, 362, 372.
	♀,	385, 390, 395, 396, 410, 420, 420 +, 420.
Tail.	♂,	198, 200, 210, 215, 218, 220, 222, 222.
	♀,	235, 235, 240, 245, 260, 265, 266, 268.

For comparison of proportions, a female *Megatriorchis doriae* measured: wing, 352, tail 330; an immature female of *Accipiter gentilis atricapillus*: wing 383, tail 305. Tail/wing ratios: *radiatus*, 1, ♀, ·64; *atricapillus*, 1, ♀, imm., ·80; *doriae*, 1, ♀, ·94.

Colours of soft parts: ♂ (? subadult); iris, pale yellowish-brown; feet, yellow; bill, blue-grey; tip black. ♂ (? juvenal); iris, yellowish-olive; feet, sulphur yellow; bill, black upper, lower bluish; cere, pale dull blue. ♀; iris, pale yellowish-brown; feet, yellow; bill, light grey, tip black.

Genus HIERAAETUS Kaup, 1844.

Type. *Falco pennata*. Ethiopian, Palaearctic, Oriental and Australian regions (5 species).

HIERAAETUS MORPHNOIDES (Gould).

Hieraaëtus morphnoides morphnoides (Gould).

Aquila morphnoides Gould, 1840 (1841), Proc. Zool. Soc. London, p. 61; Yarrundi, Upper Hunter River, New South Wales.

Aquila morphnoides coongani Mathews, 1912, Nov. Zool., 18, p. 248; Coongan River, north-west Australia. Type: AMNH No. 535063; adult male (missexed by collector as female); July 7, 1908; F.L.W. (Whitlock). Wing, 334 (worn).

Range. Australian mainland.

While the nominate race of the Little Eagle is confined to Australia, a smaller, more heavily pigmented form, *weiskei,* occurs in the mountain forests of central and eastern New Guinea. In his "Birds of Australia" Mathews pointed out the resemblances between these forms and *pennatus* of the Palaearctic region, and regarded them all as conspecific. Most authorities are now agreed that the Australian bird is distinct, and later Mathews reverted to this treatment in 1946.

We have examined 36 skins all told and can find no evidence in support of the race *coongani,* which was supposed to be a small bird. Our material is insufficient to rule out absolutely the possibility of geographical variation in colour, but since individual and age variation is great in this direction, there is no reason to suppose that such exists.

Although it is generally believed that light and dark phases occur, Fleay (1951) has drawn attention to the possibility that dark plumage may develop with increasing age. North (1898, p. 29) stated that besides being smaller, adult males are "usually darker in colour, and the abdomen, flanks, and thighs of a more uniform tint of rufous, the shaft lines always darker." An adult male from Broken Hill is actually lighter in coloration beneath than two females from the same district, and although Fleay (*loc. cit.*) has stated also that males are darker, it is felt that this distinction cannot always be relied upon. Examples of dark males have been seen from Kyabram, Victoria and Castlereagh River, New South Wales, and there is a dark female which was shot at the nest from Dawson River, Queensland.

Wing. Queensland: ♂, 343 (AMNH); ♀, 390, 393, 399 (AMNH), 370, 380, 385 (AM).
New South Wales: ♂, 334 (SAM), 345 (AMNH), 300 (juv.) (AM); ♀, 378, 380, 388 (juv.), 405 (juv.) (AM), 380, 381, 402 (SAM).
Victoria: ♀, 382 (SAM).
South and "Central" Australia: ♂, 335 (AMNH); ♀, 380 (juv.) (SAM), 374 (AMNH).
Western Australia: ♂, 334; ♀, 400 (juv.) (AM).
New Guinea (*weiskei*): ♂, 308; ♀, 327, 337, 342 (AMNH).

Young birds (juvenals) are dark—the "ginger" stage of Fleay (*loc. cit.*). They differ from dark adults in being very rufous on the head and hind-neck, darker brown on the back (although this probably fades rapidly in adults), with upper tail coverts and ventral surface a deep, dull rufous. Specimens of both sexes in this plumage have been collected in New South Wales, Victoria,

South Australia and south-west Australia, and it is possible that in life they would be mistaken for dark phase adults.

The newly hatched chick is covered in creamy-white down; iris "pale brown," cere "yellow," bill "light horn," feet "flesh colour."

The juvenal plumage is rapidly acquired, and after two months the tail is about half grown with the central rectrices dark and somewhat less strongly barred than in the adult. In the adult, colours of the soft parts are as follows: iris, "reddish brown," cere "leaden blue," bill "bluish with black tip," feet "yellowish-white."

Three birds from New Guinea (*weiskei*) in the American Museum are more heavily streaked ventrally than any from Australia. The female in this race is about the size of the male of *H. m. morphnoides,* and sexual dimorphism is equally great in both forms.

Genus AQUILA Brisson, 1760.

Type. *Falco chrysaëtos.* Synonym *Uroaëtus* Kaup. Old and New Worlds (9 species).

The single Australian member of this genus (*audax*) is often placed in *Uroaëtus* Kaup, the only character of which is that the tail is cuneate, whereas in the various species of *Aquila* it is rounded. This, in our opinion, is not of sufficient importance to warrant placing the Wedge-tailed Eagle in a monotypic genus; more particularly inasmuch as it appears to be closely related to the Golden Eagle (*A. chrysaëtos*), the type of the genus. Indeed, it is possible that *audax* is more closely related to *chrysaëtos* than is any other species of the genus.

AQUILA AUDAX (Latham).

Aquila audax audax (Latham).

Vultur audax Latham, 1801, Ind. Ornith. Suppl., p. ii; New South Wales.

Aquila audax carteri Mathews, 1912, Novitates Zool., 18, p. 247; Gracefield, Western Australia. Type: AMNH No. 535398; adult "male" (?); there is no original label on this specimen, but someone has written on the red type label of the Rothschild Museum "4-5-08 (Tunney)." Wing, 620. Coloured plate of type: Mathews, Bds. Austr. 5, plate 241, opp. p. 95.

Range. Australian mainland and southern New Guinea.

The number of skins of the Wedge-tailed Eagle preserved in Australian collections is inadequate for serious racial studies. This is partly due to the

preponderance of immature individuals and the frequency of moulting specimens, and partly because, owing to the large size of the species (which raises problems of preparation and storage), no attempts have been made by institutions to gather comprehensive series. A fully representative collection of properly-sexed individuals of all ages may reveal geographical variation on the Australian mainland, but at present we can find no evidence of this. Mayr (1937) found that a bird from Dogwa, southern New Guinea, compared "fairly well with adults from New South Wales."

Mathews described the race *carteri* in the belief that the birds of western Australia are blacker, or, at least, attain the black plumage (in which only the under tail coverts and nape remain rufous) at a younger age than do birds of eastern Australia. This would be difficult to prove except with captive birds. There is no doubt that fully adult birds are always black. H. L. White (in Mathews, 1915, p. 104) stated that a captive bird he had reared was no less than ten years old before it assumed black plumage, while Fleay (1952) has expressed the opinion that both sexes may don this plumage after six years. Old zoo birds examined by us have all been black.

There appears to be much variation in size in all parts of the range, and, as pointed out by Fleay (*loc. cit.*), unusually small individuals of either sex may be encountered. There are numerous published records of the wing span of this eagle, and some rather astonishing claims have been made by bushmen and other observers. Many records are of little value because of the neglect to distinguish age, sex, and plumage condition. Discarding a lot of reports as unreliable, Morgan (1932) found, from a series of 126 measurements of birds mainly from eastern Australia, that the average wing span was 7 feet 4 inches; there were no records less than 6 feet. The greatest wing span regarded as reliable was 10 feet, being that of a bird shot in Werribee Gorge, southern Victoria. Roche (1914) recorded 11 feet for an adult from the same locality, but this was not accepted by Morgan, who also found that the average weight of 54 birds (sexes not distinguished) was 7 pounds 15 ounces. In this case the greatest reliable record was 10½ pounds for a South Australian individual.

Considering the large proportion of young birds which fall to the gun or trap and the protracted moult of the species, the true average figures might be slightly higher than those given by Morgan, although this would be offset to some extent by the numerous reports of exceptionally large individuals, other birds being neglected by observers.

Fleay (*loc. cit.*) believes that Tasmanian birds are larger than those of the mainland, but we have found no conclusive evidence in favour of this,

neither can we refute it. He quotes one record of 9 feet 4 inches wing spread, but this has certainly been exceeded in reports from New South Wales, Victoria, and South Australia (Morgan, *loc. cit.*). Also, wing measurements of three birds in good feather from Tasmania (all females) have been found to be no greater than those of mainland birds, as shown below.

Wing. Victoria: ♂, 622; ♀, 653; 7 ♂ (imm.), 584-667 (628); 2 ♀ (imm.), 609, 667 (NMM).
South Australia: ♂, 620; ♀, 670; 3 ♂ (imm.), 590, 590, 610; ♀ (imm.), 600 (SAM).

Tail. Victoria: ♂, 444; ♀, 444; 7 ♂ (imm.), 432-457 (447); 2 ♀ (imm.), 432, 438.
South Australia: ♂, 460; ♀, 500; 2 ♂ (imm.), 420, 420; ♀ (imm.), 430.

The following description was taken from an immature male in fresh plumage collected at Peake, South Australia, in January, 1953.

Top of head, hind neck, ear coverts and back, deep buff; a very dark brown stripe along angle of jaw; rump, brown with buff edges to the feathers; tail and primaries, black; secondaries, blackish-brown; wing coverts, buffy to buffy-brown near the body; greater wing coverts, greyish-brown; chin and throat with black feathers, throat buff; foreneck, buffy-brown; breast and abdomen, dull dark brown with pale buff edges to tips of feathers. Under tail coverts, buffy-white; under wing coverts, buff; axillaries, buffy-brown. Tarsus, dull dark brown with buffy edges to feathers. Tail from below, lighter on the terminal half with dark brown bars; dark brown on basal half. Primaries 1-4 and secondaries greyish-brown with dark barrings near tip. Lores and eyelids, flesh white with black hair like feathers on lores. Iris, light hazel; bill, greenish horn with darker tips to both mandibles; feet, white; claws, black; cere, light horn; gape and inside mouth, flesh white. Wing, 590 mm.; culmen, 75 (incl. cere); wing span, 6 feet 3½ inches; weight, 7 lbs. (3175·2 grammes).

Adult male (fresh "black" plumage), Montacute, South Australia: Wing span, 6 feet; weight, 5¾ lbs. (September 28, 1947).

Adult female (fresh "black" plumage), Reedy Creek, South Australia: Iris, dark brown; feet, creamy-white; bill, horn colour with black tip; cere, gape and inside mouth, flesh-white; wing span, 7 feet 4 inches; weight, 8 lbs. 10 ozs. (May 2, 1949).

The iris has been given on various occasions also as "greyish-brown," and "yellow" for adults (? male), and "buffy-brown" in younger birds.

AQUILA AUDAX FLEAYI, subsp. nov.

Type. No. R6115, National Museum, Melbourne; adult female; Great Lakes, Tasmania; April 28, 1915; "J. E. Chubb"; wing, 653; tail, 477.

Diagnosis. Similar to birds from south-eastern mainland, but lacks the buff, golden-brown, or rufous coloration of the upper surface; the nape is buffy-white or pale buff.

Range. Tasmania.

Fleay (1952), in his excellent account of the Wedge-tailed Eagle, has drawn attention to the differences in Tasmanian birds given above. He also mentions a "slaty tinge in the wing coverts," but since only three females have been examined, we are not certain of this feature, which is entirely lacking in a large juvenal. The question of larger size in this race has already been discussed above, and while at present we feel that further evidence is required, the toes and claws in our specimens, perhaps by chance, are slightly heavier than in females from the mainland.

Wing. ♀, 667 (near adult, taken on same day as type) (NMM); 650 (juv.), (SAM).

Tail. 451+; 490 (juv.).

Genus HALIAEETUS Savigny, 1809.

Type. *Haliæëtus nisus* = *Falco albicilla*. Synonyms, *Cuncuma* Hodgson, 1837, *Blagrus* Blyth, 1846. Old and New Worlds (8 species).

HALIAEETUS LEUCOGASTER (Gmelin).

Falco leucogaster Gmelin, 1788, Syst. Nat., 1, part 1, p. 257; New South Wales, designated by Mathews.

Haliæëtus leucogaster pallidus Mathews, 1912, Nov. Zool., 18, p. 248; Point Torment, King Sound, north-western Australia (from label; the type locality was published as "Derby"). Type: AMNH No. 535486; adult male; April 1, 1911; J. P. Rogers. Wing, 555; tail, 265.

Range. From India and Ceylon across southern Asia to the Philippines, New Guinea, Solomons, Australia and Tasmania.

Very few Australian specimens from south-eastern Australia, the type locality of the White-bellied Sea-eagle, have been examined by the writers. In the American Museum there is a skin of an immature female from New South Wales, wing 630, and another, also an immature female, from Tasmania, wing 600. In the South Australian Museum are three specimens from South Australia and one from Eitape, New Guinea. Details are: South Australia, adult male,

wing 520; immature female 620; New Guinea, adult male, wing 535. Material is lacking from India and Ceylon, so that comparisons between the extremes of the range are impossible. So far as could be determined with birds from the area reaching from Sumatra to New Guinea and Australia, there is no significant geographical variation. Australian examples may, as Hartert once suggested, be a little larger. Whistler gave the wing of an adult male from Ceylon as 544, which is about the size of the Australian birds.

The species *leucogaster* is thus to be treated as a binomial unless one wishes to consider *sanfordi* Mayr, of the Solomon Islands, a race of it. The loss of the grey and white adult plumage in *sanfordi,* as well as its apparently more predatory, upland habits, indicates that Mayr was correct in giving it specific status. The White-bellied Sea-eagle has now been recorded by Ripley (1947, p. 95) from Nissan Island, an outlier of the Solomons in the direction of the Bismarck Archipelago (where the species is common). Dr. Mayr, who spent about 10 days on Nissan while with the Whitney Expedition, tells us that this party saw no sea-eagles and could hardly have overlooked them. But the species is a great wanderer among islands, and the specimen taken by Bennett and reported by Ripley might have been a straggler, or perhaps a pair or two colonized the islands subsequent to the visit of the Whitney Expedition.

Genus CIRCUS Lacépède, 1799.

Type. *Falco aeruginosus.* Synonym *Spilocircus* Kaup, 1847. Old and New Worlds (12 species).

CIRCUS ASSIMILIS Jardine and Selby.

Circus assimilis Jardine and Selby, 1828, Ill. Ornith., 1, sig. H, plate 51 and text; Sydney, New South Wales.

Circus assimilis rogersi Mathews, 1912, Nov. Zool., 18, p. 244; "50 miles up Fitzroy River" (from label), north-western Australia. Type: AMNH No. 536039; adult male; August, 1898. The field label is unsigned but does not appear to be that of J. P. Rogers (as might be expected from the name given the bird), but rather like the labels of J. T. Tunney, who was actively collecting for the Western Australian Museum at the close of last century. According to Mathews' catalogue, he got the specimen from that museum. Wing, 397. Coloured plate of type: Mathews, 5, plate 234, opp. p. 18.

Circus approximans inexpectatus Mathews, 1912, Nov. Zool., 18, p. 245; Parry's Creek, north-western Australia. As Hartert pointed out, this specimen is *Circus assimilis* in immature plumage and not *C. approximans.* Type: AMNH No. 536283; immature male; January 22, 1909; J. P. Rogers. Wing, 387.

Circus assimilis quirundus Mathews, 1915, Bds. Austr., 5, p. 23; Celebes and the northern islands (presumably Lesser Sundas). Type not in the American Museum of Natural History.

Circus assimilis celebensis Stresemann, 1924, Ornith. Monatsber, 32, p. 48; Minahasa, Celebes.

Range. Celebes, Lesser Sundas, and Australian mainland.

In an earlier revision of the Spotted Harrier, Amadon (1941, pp. 372-375) recognized three races based on size only: *assimilis,* of southern Australia (large); *rogersi,* of northern Australia and the Lesser Sunda Islands (medium-sized); and *quirundus,* of Celebes (small). This division was not proposed with confidence, for, while specimens from Celebes are numerous, all those examined by Amadon seemed to have the wing in moult, a possible explanation of their small size. The possibility that some Celebes birds are as large as southern Australian ones was substantiated when Amadon, in the summer of 1950, measured material in the British Museum. In that collection there are two females from Celebes with wings of 443 and 451, respectively, and a female from Cape York, Australia, with wing 460. These are as large as ones from southern Australia. At the other extreme, we have examined an adult male from Victoria with wing 393, a figure matched by some Celebes males. Unless southern Australian birds migrate to Celebes and mix with a smaller local race, which we doubt, it would seem that there is too much individual size variation in *Circus assimilis* to justify the recognition of races based on size. This is not meant to deny that tropical harriers of this species average a little smaller, but even of this we are not convinced. Hartert (1931, p. 40) tentatively recognized the Celebes race, but felt "uneasy" about its validity. Rensch suggested that Lesser Sundas birds are richer coloured than Australian ones, but this impression seems based on nothing more substantial than the fact that they are less often faded than those from the drier regions of Australia.

Genus FALCO Linné, 1758.

Type. *Falco subbuteo.* Synonyms include *Tinnunculus* Vieillot 1807, *Hierofalco* Cuvier 1816, *Cerchneis* Boie 1826, *Rhynchodon* Nitzch 1829, *Ieracidea* Gould 1838, *Gennaia* Kaup 1850, *Nesierax* Oberholser 1899, *Notofalco* Mathews 1913, and *Palifalco* Mathews 1946. World-wide (about 37 species).

These names have been employed by various authors as subgenera, and in some cases genera. Friedmann (1950) lists no fewer than 54 names (subgenera and synonyms) under *Falco.*

The characters of the members of this genus are so diverse that it would

be a simple matter to derive a different subgeneric name for each Australian species, without, however, gaining a true understanding of relationships. Peters' arrangement of the group (1931) is obviously imperfect, especially with regard to the Australian forms, but without having surveyed the genus as a whole we do not venture an opinion as to whether the resemblances of some species to extralimital forms is more than parallelism. Peters associates the Grey Falcon (*F. hypoleucos*) with the hobbies ("subgenus *Falco*"). Gould, on the other hand, compared it with the Gyrfalcon (*F. rusticolus*) which Peters and Friedmann (1950) separate under subgenus "*Hierofalco.*" Gurney (1882) thought *F. hypoleucos* and *F. subniger* should be placed together with the Lanner (*F. biamarcus*), another desert form, under "*Gennaia,*" which was discarded by Peters but resurrected by Friedmann, while Mathews has proposed the names "*Palifalco*" and "*Notofalco*" for the two Australian species. The subgenus *Palifalco* was differentiated from *Falco* s.str. "in proportions as follow: The bill is larger, the wing longer, the tail shorter, and the legs notably longer, while the coloration is distinctive"; and for *Notofalco*: "differs from *Rhynchodon* Nitzsch in its much longer wings, longer tail, and weaker feet." These differences are best regarded as well-marked specific characters.

Scalation of the tarsus is extremely variable in the different species. In some cases the differences are slight, while in others they are striking. In *F. peregrinus* the tarsus is covered with rather small scales which are fairly uniform in size, while in *F. subniger* and *F. hypoleucos* they are also uniform but a little larger. In *F. longipennis* there is an inner row of enlarged scales and six or seven scutella on the lower portion of the acrotarsium, and a somewhat similar condition is found in *F. cenchroides.* The Brown Hawk (*F. berigora*), which has the tarsus unusually long and "coarse" and the tarsal scales greatly enlarged, is often placed in a separate genus (*Ieracidea*) on this account, but in every other respect it is a true falcon. In the New Zealand Bush Hawk ("*Nesierax*" *novaeseelandiae*) the tarsus is somewhat like that of *F. longipennis,* but it is relatively longer, and we are inclined to associate these two species, together with the Brown Hawk, as being closer to one another than all others in the Australian region.

Friedmann (1950, p. 575) refers to the New Zealand Bush Hawk as "*Ieracidea*" (which is not a new procedure), and suggests it is intermediate between the "true falcons" and the South American "Carrion Falcons" of the genus *Milvago,* but we cannot subscribe to this.

Mathews (1915) hinted that there were important osteological differences which would support a division of *Falco,* but none have been found apart from those of bodily proportions. There is quite a lot of variation in the amount of

emargination of the primaries in the different species, but the taxonomic value of this feature is doubtful.

The Peregrine Falcon (*F. peregrinus*) is sometimes placed in a separate genus *Rhynchodon,* and the kestrels in *Cerchneis* or *Tinnunculus,* but there are not sufficient characters to warrant generic or subgeneric division.

FALCO HYPOLEUCOS Gould.

Falco hypoleucos Gould, 1840 (1841), Proc. Zool. Soc. London, p. 162; York, Western Australia.

Falco hypoleucus ashbyi Mathews, 1913, Austr. Av. Rec., 2, p. 73; South Australia. Type: AMNH No. 537628; adult male; 1902; "North." Wing, 298; tail, 146? The type is a very poor specimen with most of the feathers missing from the head.

Falco hypoleucus ashleyi Mathews, 1916, Bds. Austr., 5, p. 234 (*Lapsus* for "*ashbyi*").

Range. Interior of Australia.

The Grey Falcon is one of the least known of Australian Accipitres. It clings to semi-arid districts, and avoids the forested areas of coastal regions. Owing to limited amount of material at our disposal there is little opportunity to make geographical comparisons, but variation is scarcely to be expected in this wide-ranging species of the interior of the continent. Specimens have been examined from Parry's Creek, north-western Australia; Borroloola, Northern Territory; north Queensland; Barcoo (Victoria) River, south-western Queensland; Garah, Mungindi (both near Moree), Broken Hill, Nevertire, Wagga, Temora, Cobborah, Byrock, near Moulamein, New South Wales; and from Callabonna Creek, Laura, Yunta, and Fulham (near Adelaide—S. A. White Collection), South Australia. No important differences were detected. Wear and dirt transforms the beautiful blue-grey coloration of the fresh plumage to a dull grey.

Wing. ♂ (adult), 287, 288?, 298 (AMNH), 290, 290, 302 (AM), 268, 275, 285, 295 (HLW), 280 (SAM); (immature) 281, 286, 294 (AMNH), 265 (AM), 294 (HLW).

♀ (adult), 335 (AMNH), 325, 330, 338 (AM), 315, 320 (SAM); (immature) 297, 315 (AM), 320 (NMM).

Tail. ♂ (adult), 146? (AMNH), 155, 177, 170 (AM), 138 +, 150, 147 +, 163 (HLW), 150 (SAM); (immature) 143 (AM), 144 (HLW).

♀ (adult), 170? (AMNH), 156, 170, 174 (AM), 185, 175 (SAM); (immature) 163, 175 (AM), 180 (NMM).

In juvenals the whitish breast, foreneck and abdomen is heavily streaked and blotched with brown or blackish brown, and the back, scapulars and rump are greyish brown with pale buff edges to the feathers. The primaries are very dark grey or blackish, strongly barred with pale buffy-white, while the rectrices are grey and feebly barred dark grey, the subterminal portion being blackish, with a white tip. In adults the tail is strongly barred while the entire upper surface is blue-grey with darker shafts, and below, pale grey with dark shafts.

A female, collected at Orroroo, South Australia, in October, 1933, had iris "dark brown," feet "yellow," pharynx "grey." Wing span was 98 cm. Stomach contents: "Flesh and hair of a mouse-like creature—no bones present and flesh almost digested" (J. T. Gray).

FALCO SUBNIGER Gray.

Falco subniger Gray, 1843, Ann. Mag. Nat. Hist., 11, p. 371; Australia (Victoria fixed by Mathews).

Notofalco subniger minnie Mathews, 1915, Austr. Av. Rec., 2, p. 127; Minnie Downs, Queensland. Type: AMNH No. 537096 (adult male); January 6, 1882. According to Mathews' manuscript catalogue this was one of the specimens he acquired from the Norwegian naturalist, Robert Collett. Some or perhaps all of Collett's material from northern Australia, including, perhaps, the present type, was collected by Knut Dahl. Wing, 374; tail, 22. Coloured plate of type: Mathews Bds. Austr., 5, plate 255, opp. p. 253.

Range. Interior of Australia.

The Black Falcon, endemic to the more open country of the mainland, is a rather elusive species which occasionally visits coastal districts. Individual variation is great, but there is no geographical variation.

Mathews merely fixed the type locality in the southern part of the species' range and named a race from the northern part to have one of his names available if needed. The Mathews collection contained only four specimens of *subniger,* three from Queensland and one from Horsham, Victoria. Three carefully labelled specimens were secured in Queensland in 1940 by Messrs. L. Macmillan and J. R. Henry for the American Museum.

About thirty skins have been examined from the interior of eastern Australia, and it is thought that immatures have more white about the head than adults. A breeding (?adult) female from the Diamantina River, south-western Queensland, which was collected in July, 1918, has a very white throat, and there are some white spots on the breast, and the under tail coverts are

prominently barred with white. Most individuals have some white at the chin, although in at least two males and one female this feature is entirely absent.

The Black Falcon is at once distinguished from the extreme dark phase of *Falco berigora* by its much shorter and more powerful tarsi; the light markings on wing and tail are more sparing or absent on the tail and are whitish, not rufous.

Wing. Queensland, ♂ (ad.), 371, 371, 374; (imm.) 366 (AMNH); ♀ (ad.), 391, 392 (AMNH); 403 (British Museum).
Victoria, ♂ (imm.), 368 (AMNH).
Loc.? ♀, 405 (British Museum).
South Australia, ♂, 363, 363, 366 (SAM); ♀, 405, 405, 415 (SAM).
New South Wales, ♀, 393 (SAM).
South-western Queensland, ♀, 405 (SAM).

Tail. Queensland, ♂ (ad.), 219, 221, 222; (imm.) 215; ♀ (ad.), 223, 226 (AMNH).
Victoria, ♂ (imm.), 206 (AMNH).
South Australia, ♂, 219, 220, 220; ♀, 247, 235, 235.
South-western Queensland, ♀, 240 (SAM).

Weight. Queensland, ♂ (full breeding condition), 597; (imm.), 607; ♀ (full breeding condition), 670 grammes.

Soft part colours of a pair of breeding adults (June 14): "Iris brown, bill bluish-horn with black tip, cere bluish, legs and feet livid pale blue flesh." The skin around the eye has sometimes been recorded as "whitish" or "bluish-grey."

A chick taken from the nest towards the end of July was covered in white down with the primaries (brown) just showing. The irides were "dark brown," bill "pale bluish-horn," cere "pale bluish-horn," feet "pale bluish."

In the juvenal the cheeks are often buffy-white, the throat is whitish with dark brown streaks, and a moustachial stripe is visible. In some juvenals also the rectrices and primaries are indistinctly barred with pale buff, but we have been unable to trace the sequence of plumage changes to the adult condition from the limited material at our disposal.

FALCO PEREGRINIS Tunstall.

Falco peregrinus macropus Swainson.

Falco macropus Swainson, 1837, Anim. in Menag., p. 341; Tasmania.

Range. Australia (except south-western Australia), Tasmania.

The Peregrine Falcon, of which about 18 races may be listed from most

parts of the world, is widespread but not very plentiful in Australia. Altogether we have examined 58 skins of juvenals and adults in the museums in Adelaide, Melbourne and Sydney, and there are eight specimens in the Mathews collection in New York.

Available material is rather disappointing as it is largely composed of immature individuals. The head, cheeks and malar region are dull black in adults and brownish or brownish-black in juvenals, and while individual variation is prevalent, females are distinguished by a stronger buffy wash on the ventral surfaces, but this colour may also be an indication of age and geographic variation. From Tasmania, the type locality of *macropus,* we have two adult birds, unsexed but obvious males, in which the characteristic ventral buffy wash is almost lacking and replaced by grey on the abdomen, flanks and thighs. Further material may show that the island birds are a distinct population, but this is doubtful.

From the drier areas of the mainland, specimens are somewhat paler than those from eastern Australia, and there is often a reduction of the ventral barring, characters which in part may be due to fading and abrasion, especially as the moult is irregular and prolonged.

No geographic variation in size has been detected in Australian birds, which have average dimensions only slightly below those of the American and British races.

Wing. Tasmania, ♂ (ad), 280, 290 (SAM).
Victoria, ♂ (ad.), 280; ♂ (juv.), 280, 285, 290; ♀ (juv.), 332-344 (338·5) (NMM), 337 (HLW).
New South Wales, ♂ (ad.), 285-300 (293) (AM), 290 (HLW); ♂ (juv.), 289-300 (294); ♀ (ad.), 305-340 (327) (AM), 325 (SAM); ♀ (juv.), 320-348 (330·7) (AM), 320-330 (332·3) (HLW), 330 (SAM).
South Australia, ♂ (ad.), 270, 282, 295; ♀ (ad.), 325, 325, 328; ♀ (juv.), 325, 335 (SAM), 328 (HLW).

Tail. Tasmania, ♂, 144, 164.
Victoria, ♂ (ad.), 163; ♂ (juv.), 155, 162, 165; ♀ (juv.), 174-185 (179·7), 175.
New South Wales, ♂ (ad.), 140-145 (142), 160; ♂ (juv.), 148-155 (150·7); ♀ (ad.), 170-185 (175), 170; ♀ (juv.), 173-195 (182); (182); 170.
South Australia, ♂ (ad.), 135, 144, 158; ♀ (ad.), 170, 170, 170; ♀ (juv.), 162, 172, 174.

In fresh juvenal plumage the feathers of the crown are tipped with cinnamon buff and the nape region may be of the same colour; there is often a pale rufous auricular patch, but the cheeks and malar region are dull black. The upper surfaces are dark brown with cinnamon buff or pale buff tips to most of the feathers, and the tail coverts are barred with the same colour as also are the rectrices (incompletely). Ventrally the ground colour is a buffy-white, becoming deeper on the abdomen, and the breast and abdomen have well-defined brownish stripes which become sagittate on the flanks and thighs. The duration of the juvenal plumage is unknown, but fading is common and wear (or partial moult?) may cause a reduction in the intensity of the ventral stripes. It is possible that this plumage is retained for more than one year.

A juvenal breeding female in wore plumage has some new grey (barred) feathers on the lower scapular region, and the upper tail coverts are completely replaced with grey feathers with darker barrings, as in the adult condition. This bird was shot at the nest in October near Burra, South Australia. A male taken on the Upper Murray River, in May, has acquired full adult plumage, including the strongly barred grey tail, but the head is like the juvenal, and there is a trace of rufous at the nape.

Signs of moulting have been observed in skins taken at all seasons of the year, but this process probably begins in spring and is completed by the following winter.

A juvenal female collected at Two Wells, South Australia, in February, 1933, weighed 2 lb. 2 oz.

Falco peregrinus submelanogenys Mathews.

Falco peregrinus submelanogenys Mathews, 1912, Austral Av. Rec., 1, p. 33; "Bokerup, Plantagenet Arch," south-western Australia. Type: AMNH No. 537365 (?) near adult female; April 14, 1900; J.T.T. (Tunney), Wing, 320; tail, 175. Figured, Mathews, Bds. Austr., 5, plate 254, opp. p. 241.

Range: South-western Australia.

Diagnosis. About the size of *F. p. macropus,* from which it differs in being pale rufous on the foreneck and upper breast, and deep rufous on the lower breast and abdomen, with blackish shaft lines and regular cross barrings.

It would appear that this race is confined to South-west Australia. A single adult female in the American Museum from north-western Australia is much paler above and below than Mathews' type (cf. Mayr, 1941, p. 1), and South Australian birds are also rather light-coloured.

Certain features of the type of *submelanogenys,* such as buff tips to the feathers of the dorsal surface, suggest that it may not be quite adult. The

only other specimen we have examined from south-western Australia is contained in the H. L. White collection. It is a juvenal male with a few adult feathers on the back and scapulars (from Pallinup River), and is much darker below than eastern birds in similar plumage. The breast and abdomen are a deep, dirty buff with heavy blackish markings, and the foreneck is buffy-white, with some grey adult feathers appearing on the back and rump. Wing, 290; tail, 153.

Reference to "The Birds of Western Australia," by Serventy and Whittell (1951, p. 210), reveals that these authors regard the normal coloration of the breast of the adult as "chestnut-brown," with the abdomen, flanks, thighs and under wing coverts "chestnut" with blackish spots and barrings, but we have seen nothing from *eastern* Australia which will answer to this description.

It is true that the amount of buff colouring on the ventral surface is subject to individual variation, as mentioned by several authors, including Mayr (1941), and we have before us an adult male from Cobborah, New South Wales (February taken), which is quite dark below, as well as four juvenal females from the same area. Nevertheless, we anticipate that further material will confirm beyond all doubt that south-western birds are distinct.

Mathews claimed in his original diagnosis that *submelanogenys* was large, but later, in his "Birds of Australia," stated that eastern Australian individuals were larger than those from the west. Actually there are no appreciable differences.

FALCO LONGIPENNIS (Swainson).

The Little Falcon occurs in all parts of Australia and Tasmania, and in winter it is believed that some birds visit southern New Guinea and other islands to the north of the continent. A well-marked race, *hanieli* is resident on the Lesser Sunda Islands; it is small, and pale ventrally. In Australia, two geographical races are recognizable, a southern *longipennis* and an interior and northern *murchisonianus*. Altogether, we have examined 90 specimens in the museums of Adelaide, Melbourne and Sydney, and there are 67 skins from Australia in the American Museum.

Adequate material for comparison from Western Australia is lacking, but the few skins we have examined from that area have raised certain problems concerning plumage coloration, which will be discussed below.

Falco longipennis longipennis Swainson.

Falco longipennis Swainson, 1837, Anim. in Menag., p. 341; Tasmania.

Falco melanotus White and Mellor, 1913, Emu, 12, p. 164; Flinders Island, Bass Strait. Not Shaw, 1809, Gen. Zool., 7, i., p. 86.

Falco longipennis samueli Mathews, 1916, Bds. Austr., 5, p. 232; new name for *melanotus* White and Mellor.

Range. Tasmania, islands of Bass Strait, and the more humid areas of southern, eastern and south-western Australia; (?) mid- and north-western Australia.

Diagnosis. Head, hind neck, cheeks, auriculars and malar region sooty black; upper surfaces very dark grey; upper breast deep buff with heavy blackish streaks, becoming rufous brown on the lower breast and abdomen, with heavy blotches and barrings of blackish coloration, these markings extending to and becoming darker on the sides and flanks, with some scattered pale buff blotches.

Individuals of the nominate race are at once recognized by the black head and extensive blackish markings on the under surfaces. In eastern Australia this race occurs in the humid coastal regions bounded approximately by the Dividing Range from southern Victoria to southern Queensland. The occurrence of similar dark birds in South-west Australia and other localities in that State might suggest that dark birds are merely a colour phase, but we have seen no dark birds from the interior, and no light specimens have been collected in Tasmania nor the coastal regions of the south-east. In the American Museum there is a very dark adult female from Parry's Creek, north-west Australia (February taken), as well as two dark immature females from mid-west Australia (De Grey River, June 28, and Pt. Cloates, March 14). Possibly these birds were migrants or wanderers from further south, where dark individuals very similar to those found in south-eastern Australia occur. The southern form of the Collared Sparrowhawk has also been taken at De Grey River. The affinities of South-west Australian birds with those of south-eastern Australia is well known in many groups, and at present it is preferable to unite the two populations under *longipennis,* although a specimen of an adult female from King George's Sound, taken in February and now housed in the Australian Museum (No. 023881), has prominent blackish streaks on the breast *only* and is more rusty rufous below than most others. Dark individuals from South-west Australia have been examined from the following localities—Armadale, Gordon River, King George's Sound, Lake Muir and Wilson's Inlet. As expected, a skin from Zanthus belongs to *murchisonianus.*

Females in both races appear to be slightly more heavily pigmented than males, but the present form is a striking one and readily separable, even though intergradation occurs with *murchisonianus* in certain areas. Characters are variable in birds from north of the main Divide in Victoria, south-eastern South Australia, and in the vicinity of Wagga, Parramatta, Lithgow, and Yandembah,

New South Wales, and Queensland coastal regions north to Cairns. In these areas some birds are dark above and light below, while others show the reverse condition, and usually the head is not so intensely black; perhaps they are better classed under *murchisonianus*.

Wing. Tasmania, ♂ (ad.), 230 + (worn) (RAOU collection).
Victoria, ♀ (ad.), 264 (SAM).
New South Wales, ♂ (imm.), 242; ♀ (imm.), 265, 272 (AM).
Queensland, ♂ (ad.), 245 (AM).
South-west Australia, ♂ (ad.), 245 (NMM); ♂ (juv.), 238 (HLW); ♀ (juv.), 242, 245 (AM).

Juvenals are generally darker than those of the pale form. The head is brownish black with a rufous tinge, the upper surfaces dark brown with dull rufous edges to the feathers, while ventrally the throat is pale buff, breast and abdomen rufous brown with brownish black stripes and markings; thighs and centre of abdomen and under tail coverts deep buff.

Falco longipennis murchisonianus Mathews.

Falco lunulatus murchisonianus Mathews 1912, Nov. Zool., 18, p. 252 (January 31); East Murchison, Western Australia. Type: AMNH No. 537513; adult male; September 22, 1909. "F.L.W." (Whitlock). Wing, 247.

Falco lunulatus apsleyi Mathews, 1912, Austral. Av. Rec., 1, p. 33 (April 2); Melville Island, Northern Territory. Type: AMNH No. 537523; immature female, moulting into adult plumage; October 22, 1911; J. P. Rogers. Wing, 262 (imm. primaries).

Range. The drier parts of Australia, extending to the Kimberleys, Western Australia, and coastal Northern Territory.

Diagnosis. Differs from the other Autsralian race in its much paler coloration above and below. The head is brownish black with a rufous wash; cheeks and malar region brownish black; upper surfaces pale grey with black shaft lines; primaries greyish brown instead of brownish black. Ventral surface pale rufous brown, with the heavy blackish markings of the nominate race reduced to narrow brownish stripes on the upper breast and indistinct greyish barrings on the sides and flanks.

Examples of this race have been collected from such widely separated localities as Derby and Zanthus, Western Australia, the Gulf of Carpentaria, Queensland, and Cootamundra, New South Wales. Of "*apsleyi*," Mathews stated that it was similar in colour to *murchisonianus* but larger; judging from

the few northern skins at our disposal, this seems unlikely. There is a perfect gradation between *F. l. longipennis* and *l. murchisonianus*, but the differences between typical examples of each form are marked and it is surprising that this fact has not been emphasized previously.

Measurements, except where otherwise indicated, are from skins in the South Australian Museum.

Wing. North-west Australia, ♂ (imm.), 245 (AM); ♀ (imm.), 265, 273.
Northern Territory, ♂ (ad.), 244; 248 (AM); ♀ (ad.), 267, 276, 278.
Queensland, ♂ (ad.), 248; ♂ (imm.), 237; 240 (NMM); ♀ (ad.), 268; 270 (NMM); ♀ (imm.), 267.
South Australia, ♂ (ad.), 242, 243, 240, 240 +; ♂ (imm.), 238; ♀ (ad.), 245 +, 250, 255 +, 255, 271, 272; ♀ (imm.), 267, 272.
New South Wales and Victoria, ♂ (ad.), 235 +, 237, 244 (SAM), 242 (NMM); ♂ (imm.), 235 (NMM); ♀ (ad.), 266; ♀ (imm.), 267, 275 (SAM), 265 (AM).
South-western Australia, ♀ (ad.), 268 (NMM).

Juvenals are markedly different in coloration from adults. The top of the head is bright rufous with very narrow blackish shaft lines, the upper surfaces are dull brown with rufous edges to the feathers, and the two central rectrices are similarly coloured with incomplete rufous barrings and a broad rufous tip. Cheeks and malar region are brownish black, throat and upper breast pale buff becoming a bright rufous brown on the breast and abdomen and darker rufous on the sides. Dark markings are limited to the upper breast and thighs and are brown and very little wider than the central dark shafts.

Moult commences on the head and scapular region, the rectrices being replaced last. From numerous juvenal specimens it would seem that the juvenal plumage is retained for less than one year when the assumption of adult plumage is commenced in spring, the whole process taking at least six months. A few examples have indicated that moulting may also commence at the end of autumn, but these may be individuals which were hatched early in the previous season. The normal breeding period for this race is between August and January.

Sodrrberg (1919, plate 1) shows, in natural colours, a juvenal in fresh plumage (fig. 3) and what he believes to be an adult with bleached plumage (August-taken) in fig. 2. Actually this last-named illustration is of a juvenal in worn and faded plumage, which is frequently met with just prior to the commencement of the moult.

Colours of soft parts. Adult (sexes similar): iris, dark brown or (?) reddish (one record); bare space around eye bluish white, pale blue or bluish grey; cere, greenish yellow; bill, bluish horn with dark tip to upper mandible and darker mottlings on the lower; legs and feet, yellow; claws, black. The iris may be paler in juvenals.

Weight of four adult females, collected between June and August: 247, 248, 325, 420 grammes. Wing span of two adult females, 30¾ inches, 33 inches.

FALCO CENCHROIDES Vigors and Horsfield.

Falco cenchroides cenchroides Vigors and Horsfield.

Falco cenchroides Vigors and Horsfield, 1827, Trans. Linn. Soc., London, 15, p. 183; New South Wales.

Cerchneis unicolor Milligan, 1904, Emu, 6, p. 2; Yalgoo, Western Australia. Type said to be in Western Australian Museum, Perth.

Cerchneis cenchroides milligani Mathews, 1912, Nov. Zool., 18, p. 253; the type locality was published as Parry's Creek, north-western Australia, but the field label says "Point Torment, King Sound." Since there is a specimen taken by the same collector at Parry's Creek, it is possible that the type label was tied on the wrong specimen, but this cannot be proved. Type: AMNH No. 538594; adult male; January 7, 1911; J. P. Rogers. Wing, 232 (?) (worn); tail, 149 (?) (worn).

Range. Australia and Tasmania, straggling to Aru, Ceram, the Moluccas, and Babber, South-west Islands. A number of stragglers have been recorded from widely separated localities in the north and south islands of New Zealand.

The Nankeen Kestrel is very plentiful in southern Australia and probably a permanent resident in many districts. However, it is possible that seasonal or other movements may occur, because four specimens which were taken in Ceram, Moluccas (April 29) and Babber, South-west Islands (August 24, 29, September 1) are inseparable from Australian birds and presumably migratory stragglers.

Careful comparison of material from all parts of Australia reveals no geographical variation, although a larger series might show interior birds to be a little smaller. We have seen no specimens from Tasmania. Mathews, at least at one time, believed there were no subspecies in Australia, and Hartert (1931, p. 46) was of the same opinion.

The plumages of the Nankeen Kestrel present some problems which, perhaps, can only be answered by study of birds of known age, i.e., ones kept in captivity for a period of several years. Individuals with heavy black barrings and

hastate markings on the back and wings and prominent stripes on the head are rare in collections but appear to be first year birds. Ventrally, the breast is deep rufous with dark brown streaks, and females are much darker generally in this plumage than males. Study of skins has established that in males first the rump, then the tail, and finally the head becomes grey, and this involves several months. A few specimens with rufous rectrices were found to be males although labelled as females, and this was confirmed by the presence of a grey rump, which never seems to be present in the last-named, even in old birds with greyish tails. The rufous immature rectrices are barred with black in both sexes, but more strongly in females. In the adult the central pair is usually almost immaculate (except for the subterminal black band), and the barring is much reduced on the others. From one or two males with the tail in moult it is evident that, even in the adult, the new rectrices are quite rufous at one stage; the whitish or even grey colour is in part acquired later as a result of fading; but the feathers do have a glaucous sheen. In most adult males with grey tails the edges of the rectrices are rufous in fresh plumage. The grey of the head in the male seems to be partly a matter of wear as well as age; in females the head is rufous with dark shaft lines, never grey.

In the tail of the adult female the barring often becomes reduced throughout with maturity and is absent in the central pair of rectrices. The tail is usually rufous in females at all ages, but in one specimen it is quite greyish, but the rump is rufous.

Fading of the plumage appears to be rapid and prevalent in birds even in southern districts. A female, taken in South Australia in December, shows the new rectrices (nearly half-grown) of a much deeper shade than the remainder of the rufous feathers of the dorsal surface. Juvenals in fresh plumage have a decided rufous or buffy wash ventrally, especially on the upper breast, and the dark shaft lines, which extend from this area to the sides of the body, are wider and heavier than in adults. Males are paler rufous below and with less dark striping than members of the opposite sex.

In the adult, the dark markings of the dorsal surface are much reduced and confined to the head, scapulars and secondaries, and in some old males are almost absent.

Sexual dimorphism in this species, as in kestrels in general, is much less than in some members of the genus *Falco*. Nevertheless, unusually small individuals are fairly common, especially amongst males.

Adult males of *cenchroides* in good feather seldom have a wing length as great as 255 mm., while in females the wing is almost always more than 255, generally 260 or more and reaching 275.

Colours of the soft parts (sexes alike): iris dark brown; bill dark blue at tip, lighter at base; cere, legs and feet yellow; eyelids yellow with a greenish tinge. Weight (female, juvenal, March), 128 grammes; female adult (December), 272·2 grammes. Span of wings: Female juv., 29¼ inches; female adult, 30½ inches.

Falco cenchroides baru Rand.

Falco cenchroides baru Rand, 1940, Amer. Mus. Novit., 1072, p. 1; 11 km. N.E. of Mt. Wilhelmina.

Range. Oranje Range, New Guinea.

Examination of our specimens of this well-marked race (and other species of kestrels) suggests that the Australian form of *cenchroides* is in a somewhat transitional stage as regards sexual and age colour dimorphism. In adult males or *baru* the grey of the head is much deeper than ever it is in the nominate race, and it extends around to the sides of the throat; the tail is also greyer with further suppression of the black barring (except the subterminal band). This increase of the grey elements in the plumage is reflected in the immature stages, at least as regards the tail, for a two-thirds grown nestling has the tail feathers grey except for rufous tips. These feathers have more black bars than those of the adult, although much fewer than are found in immatures of *cenchroides*. The crown of this nestling of *baru* is rufous. In the adult female the head and tail are grey, though the former is not such a clear grey as in the male.

When describing *baru*, Rand hinted that *cenchroides* and *tinnunculus* might be regarded as conspecific by some workers, but the occurrence of two sympatric species, *tinnunculus* and *naumanni*, in southern Europe argues against too much species lumping in the group.

On Ceram, at least, there is resident *Falco moluccensis* which might be regarded as a geographical representative of *cenchroides*. This form, perhaps because of its tropical habitat, has less sexual dimorphism than *cenchroides* or *tinnunculus*, and most workers regard it as a distinct species.

NEW FORMS DESCRIBED.

Aviceda subcristata njikena (Fitzroy River, Western Australia).
Haliastur indus flavirostris (Bougainville Is., Solomons).
Aquila audax fleayi (Great Lakes, Tasmania).

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LATE TERTIARY MARSUPIALS FROM SOUTH AUSTRALIA

By R. A. STIRTON (Museum of Paleontology, University of California)

Fig. 1-11

INTRODUCTION.

In 1953 Richard H. Tedford and R. A. Stirton received Fulbright awards to search for Tertiary marsupials and monotremes in South Australia. Tertiary mammalian remains have turned up from time to time on the mainland of Australia but the stratigraphy and in many instances the exact localities of these important discoveries have not been adequately recorded.

Some fossils now thought to be Pleistocene are surely Pliocene and others may be older. This is particularly true of some of the specimens said to have come from the Darling Downs area in Queensland. Also during the past few years Edmund D. Gill, of the National Museum, Melbourne, has been stressing an earlier age for some of the fossils from Victoria. Four of his marsupial specimens from marine formations should be helpful in establishing a correlation between continental and marine formations.

Our 1953 expedition was a co-operative project between the South Australian Museum, the Department of Geology of the University of Adelaide, and the Museum of Paleontology of the University of California. Those who actively participated in different phases of the field work were Norman B. Tindale, Paul F. Lawson, Geoffrey D. Woodard, Harold C. Reynolds, Tedford and Stirton. Though we worked in human cultural levels at Lake Menindee and in the *Diprotodon* locality at Lake Callabonna, our prime objective was to locate concentrations of Tertiary mammals to initiate work on the continental stratigraphy of Australia.

Toward the end of our last trip in the interior Woodard discovered a concentration of late Tertiary mammalian materials in a sandy channel deposit along the edge of Lake Palankarinna east of Lake Eyre. In the limited time available we collected from that site a series of macropodid jaws, teeth and limb bones, parts of two kinds of diprotodonts, a fragmentary bandicoot mandible as well as numerous crocodilian and chelonian fragments, teleost bones, lung-fish teeth and crayfish gastroliths (Stirton and Woodard, 1954).

This report gives preliminary descriptions of the mammals and is not a comprehensive faunal report. We hope to secure a more varied faunal representation and better preserved materials after we open a quarry at the Woodard locality in July, 1954.

ACKNOWLEDGMENTS.

We are grateful to Sir Douglas Mawson, Professor A. R. Alderman, Mr. Herbert M. Hale, Mr. C. Warren Bonython and our many other Australian friends without whose help and encouragement this project would have been impossible. We also wish to express our appreciation for the Fulbright awards, to the Associates in Tropical Biogeography at the University of California and others who helped to make this work possible. Dr. A. T. Hopwood, of the British Museum of Natural History, kindly placed at the author's disposal Owen's types and generously took much of his time in discussing his ideas on some of these specimens. Mr. and Mrs. D. J. Oldfield, of Etadunna Station, were most hospitable and helped us in many ways. Mr. Jack Stewart, of the Electricity Trust Company at Leigh Creek, gave us invaluable assistance and suggestions with our transportation problems. The illustrations were prepared by Mr. Owen J. Poe, staff artist in our Museum. All measurements are in millimeters.

TYPE, LOCALITY AND AGE OF THE PALANKARINNA FAUNA.

The Woodard locality where the fossil bones were found is a grayish sandy channel deposit with some unconsolidated ferruginous concentrations ranging from one-fourth of an inch to two inches in diameter. Gypsum occurs throughout the beds but most if not all of it is secondary in origin. These channel sands were laid down in a formation composed primarily of greenish-blue and red gypsiferous clays with a basal conglomerate derived from the Duricrust chert. The channel sands are 35 feet above the basal conglomerate. The maximum thickness of the formation where the channel sands occur is 72 feet, though the total thickness may be greater.

The exposures are along the west side of Lake Palankarinna, east of Lake Eyre; 18 miles S. 75° W. of Etadunna Station homestead. Military grid reference 656431, ordinance sheet Marree, South Australia, H54/1.2.5.6, zones 5 and 6, first edition 1942, scale 1 : 506880. U.C. locality V5367 (Fig. 1).

Age of the fauna is difficult if not impossible to determine accurately at this time. Perhaps the best key to an age is the fragmentary notothere (Fig. 6) that seems closely related but more advanced than a specimen in the National Museum at Melbourne. The Victorian specimen came from the Sandringham sands ("Cheltenhamian stage" of Singleton, 1941) at Beaumaris. Singleton (1941), Gill (1950). and Glaessner (1951) refer this "stage" to the late Miocene, and Crespin (oral communication) calls it early Pliocene. The Palankarinna fauna therefore has been referred to the early or, possibly, middle Pliocene.

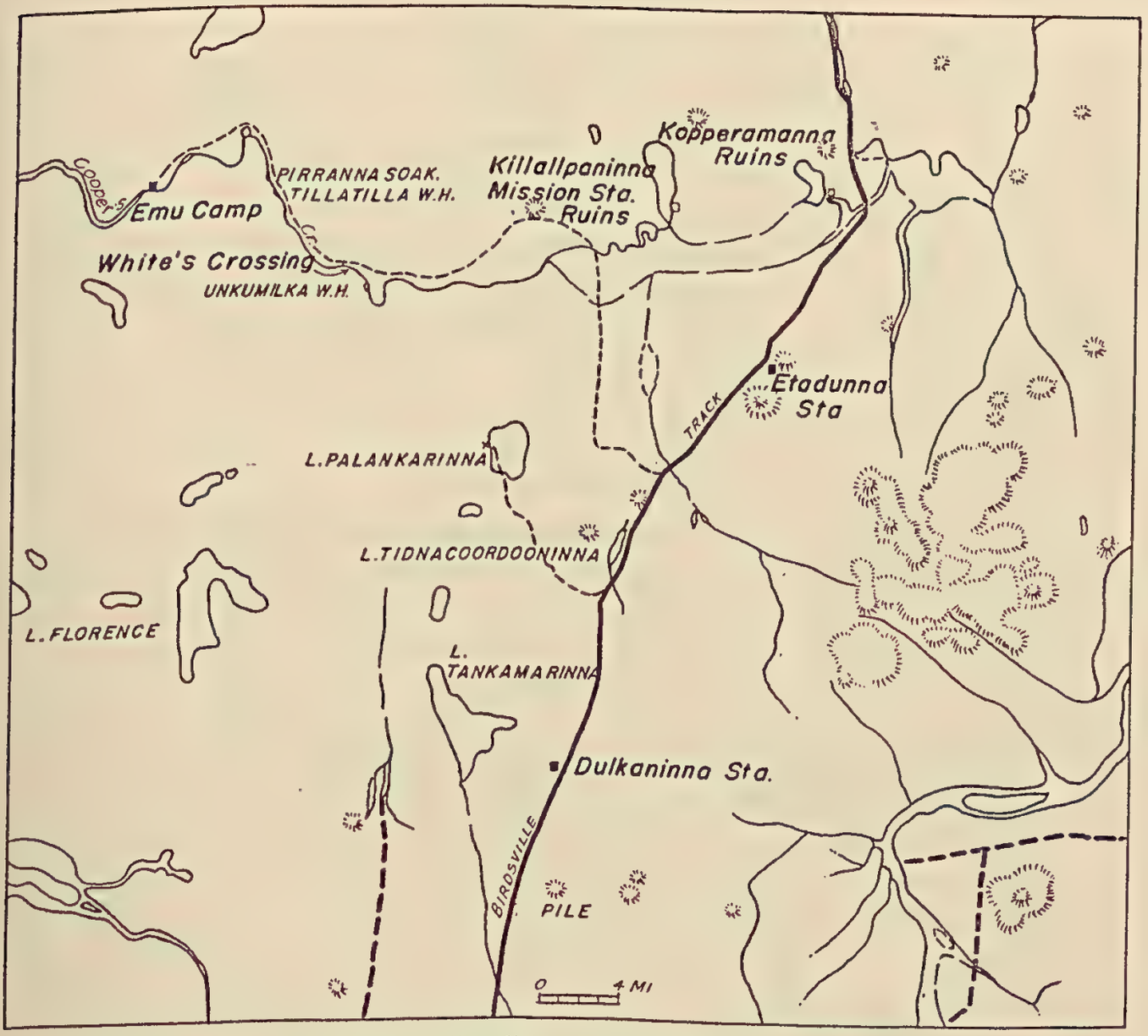

Fig. 1. Map showing Woodard Locality at Lake Palankarinna east of Lake Eyre, South Australia.

PALANKARINNA FAUNA—WOODARD LOCALITY.

FAMILY PERAMELIDAE.

The first Tertiary fossil of a bandicoot was found by Mr. Tedford on July 30, 1953, when we were opening the Palankarinna quarry. Unfortunately it was in the weathered zone near the surface and consequently was badly shattered.

Genus ISCHNODON[1] nov.

Type of genotypic species. Ischnodon australis sp. nov.

The diagnostic characters of the genus are those of the genotypic species until other species have been described.

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(1) ἰσχνός, thin; ὀσών=ὀδούς, tooth.

ISCHNODON AUSTRALIS sp. nov.

Holotype. Most of anterior half of right mandible with posterior edge of canine alveolus, P_{1-2} and M_{1-2} in place. P_3 missing from alveolus, M_2 with crack across talonid resulting in loss of posterolingual corner (Fig. 2). U.C. No. 44380.

Generic diagnosis. Horizontal ramus slender; premolar thin transversely (P_1=1·1; P_2=1·6), with long gently declining crest from anteromedian cusp to talonid. Paraconid and hypoconulid reduced on molars; talonid as high as trigonid; height from base of enamel below metaconid–M_1=2·0; M_2=2·1; stylar cusp at anterior base of hypoconid of M_1.

DESCRIPTION.

Mandible. Horizontal ramus evidently nearly straight, perhaps with slight convexity of lower border below molars; depth of mandible below P_1–5·4, below

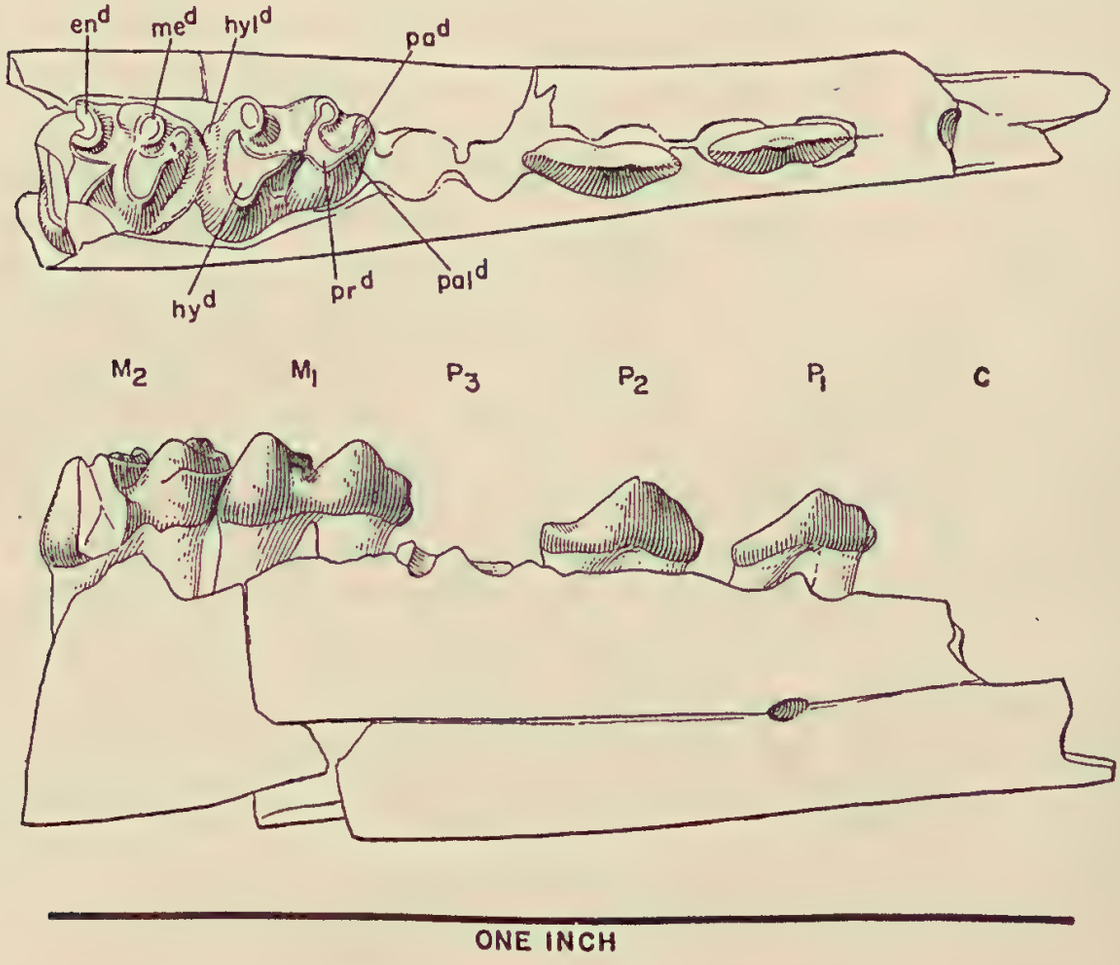

Fig. 2. *Ischnodon australis,* Stirton, n. gen. and n. sp., holotype, No. 44380; Woodard Locality V5367, Palankarinna fauna; Etadunna formation. Most of anterior half of right mandible with posterior edge of canine alveolus, P_{1-2}, alveolus for P_3, and M_1–M_2. Occlusal and labial views. Four times natural size.

anterior edge of M_1–7·0, transverse thickness below M_1–4·9; mental foramen below P_1. Horizontal ramus slender, evidently indicative of long narrow-faced animal.

Teeth. Posterior edge of alveolus of canine preserved; diastem between C and I_1–2·0; P_1 with anteromedian cusp 1·9 high; no tiny cusp at anterior end; long gently declining talonid without cusp; straight; very narrow–1·1; length–3·6. Diastem between P_1 and P_2–1·2. P_2 with anteromedian cusp 2·3 high; no tiny cusp at anterior end; long gently declining talonid with posterior stylar cusp, outline straight lingually and convex labially; wider than P_1–1·6; length–4·1. P_3 missing. Distance between P_2 and M_1–3·5. Molars basically tuberculosectorial but with talonid as high as trigonid; M_1 triangular in outline, lingual edge straight, labial edge tapers from posterolabial corner to anterolingual corner; paralophid and paraconid present; paraconid not in line with metaconid and entoconid, paraconid separated from metaconid by distinct metaflexid; no anterior cingulum; metaconid and entoconid equal in size; hypoconulid vestigial; small stylar cusp at anterior base of protoconid; length 4·1; width across trigonid–2·5, across talonid–3·0; height of metaconid 2·0. M_2 differs from M_1 in less pronounced triangular outline; paraconid reduced; paralophid closely appressed to protolophid; prominent anterior cingulum with stylar cusp at anterior base of protoconid; larger size, length–4·2; width across trigonid–3·2, across talonid–4·5; height of metaconid–2·1.

Comparisons. The exact relationships of the Palankarinna bandicoot cannot be determined from the fragmentary specimen at hand. Nevertheless there are features in the teeth that suggest affinities with living genera. The long gently declining crest from the anteromedian cusp to the talonid on P_1 and P_2, and the reduction of the paraconid and the hypoconulid on the molars are suggestive of affinities with the bilbies. On the other hand, the pattern and height of crown in the molars are much like the features seen in *Thylacis* Illinger (=*Isoödon* Desmarest), but the presence of the paraconid and the hypoconulid, though reduced, may be evidence of a remote relationship to both *Thylacis* and *Perameles*. The characters displayed in this specimen seem to indicate that the Palankarinna animals were nearer to bilbies than to the other genera of the Peramelidae.

Choeropus evidently represents another specialized form related most closely to *Perameles*. The premolars in the Palankarinna specimen are relatively and actually longer and are relatively shorter crowned than in *Choeropus*. Furthermore there are no diastems between the premolars of *Choeropus*. Other differences are reflected in the molars; though considerably larger they are relatively

much lower crowned than in the pig-footed bandicoot. -The paraconids and hypoconulids, also, are more reduced. *Choeropus* is a much smaller animal. The fossil form may be ancestral (but probably is not) to bilbies. If it is in a direct ancestral position the bilbies have experienced considerable evolution in their dentition, especially in becoming higher crowned and in the loss of the paraconid, since the Palankarinna fauna existed in the area east of Lake Eyre.

FAMILY MACROPODIDAE.

Macropodid remains were more numerous at the Palankarinna site than all the other fossils combined. Even in the limited time available for collecting on our first trip to the locality we found a representative of every tooth both permanent and deciduous. Eventually we should have an excellent series for a study of variation in the population.

This new genus and species is recognized as a member of the Macropodinae. Detailed comparisons with other genera in the subfamily have not been completed for this preliminary report.

Genus PRIONOTEMNUS[2] nov.

Type of genotypic species. *Prionotemnus palankarinnicus* sp. nov.[3]

The diagnostic characters of the genus are those of the genotypic species until other species have been described.

PRIONOTEMNUS PALANKARINNICUS sp. nov.

Holotype. Right mandible with P_3–M_4 in place, most of angle, ascending ramus, part of symphysis and incisor missing (Fig. 3), U.C. No. 44381.

Paratypes. Left maxillary with P^3–M^4, U.C. No. 44382 (Fig. 4). Left maxillary with P^2, DP^3, M^1–M^3 in place, M^4 still imbedded in the maxillary, U.C. No. 44384. Left mandible with P_3–M_3 in place, M_4 empty; most of angle, ascending ramus, part of symphysis and incisor missing, U.C. No. 44385. Right mandible with P_3–M_4 in place; most of angle, part of ascending and incisor missing, U.C. No. 44386. Left mandible with P_3–M_4 in place; angle, part of ascending ramus, symphysis and incisor missing, U.C. No. 44387. Part of right mandible with M_{3-4} in place; front half broken off, angle nearly complete, most of ascending ramus missing, U.C. No. 44388. Part of left mandible with P_2 DP_3 M_{1-2} in place, M_3 still embedded in the maxillary, U.C. No. 44839. Right metatarsal IV and associated phalanges, U.C. No. 44383 (Fig. 5). Right

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(2) πριων, saw; τέμνυς, to cut (in reference to the premolars).
(3) Named for the type fauna at Lake Palankarinna.

P^3, U.C. No. 44390. Composite upper incisors, U.C. No. 44391. Left P^2, U.C. No. 44392. Symphysis of left mandible, U.C. No. 44393. Left lower incisor, U.C. No. 44394. Right P_2, U.C. No. 44395, left DP_3, U.C. No. 44396.

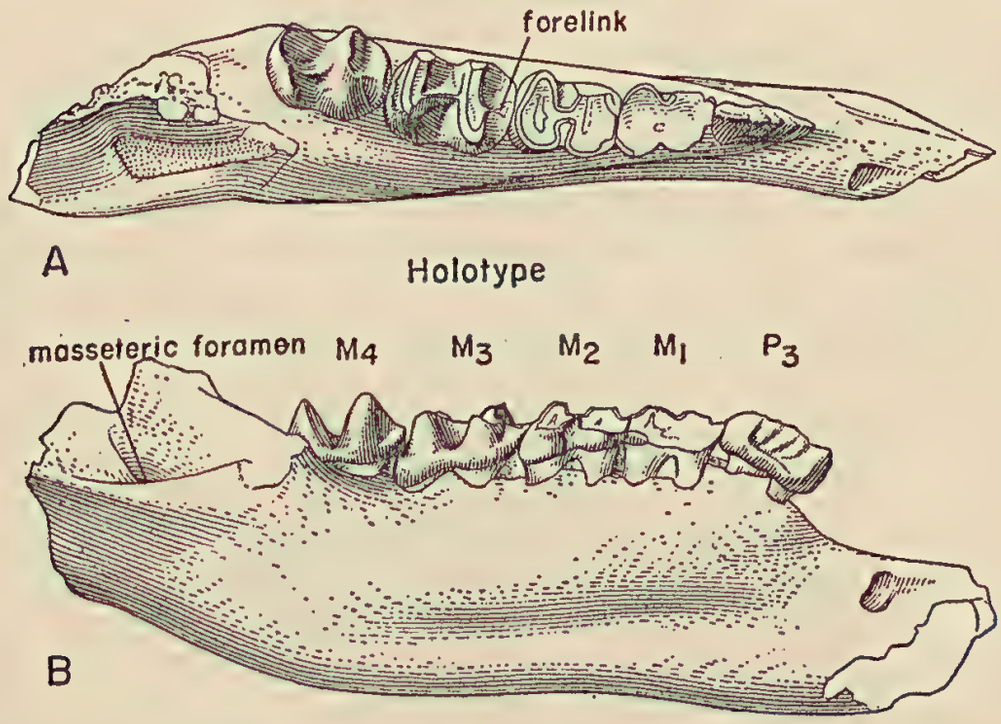

Fig. 3. *Prionotemnus palankarinnicus*, Stirton, n. gen. and n. sp., holotype, No. 44381; Woodard Locality V5367, Palankarinna fauna; Etadunna formation. Right mandible with P_3–M_4; most of angle, ascending ramus, part of symphysis and incisor missing. Occlusal (A) and labial (B) views. Natural size.

Generic Diagnosis. Partial forward rotation of molars. P^2 with no lingual basin; labial surface slightly convex and lingual surface slightly concave. P_3 with four labial and four lingual grooves. P^3 not longer than M^4 nor shorter than M^3; P^3 with narrow lingual shelf and narrow lingual basin; prominent posterointernal cusp; tiny posterointernal fossette. M^1 and M^2 nearly quadrate. $I^{2(4)}$ with enamel extending upward from ventral border nearly halfway on lingual surface; relative proportions of I^2 as in *Wallabia* but larger. P_2 with long, deep and narrow anterior lingual groove and shorter wide posterior lingual groove divided into three parts by two short ridges in apical area of unworn teeth. P_3 usually equal in length to M_2 sometimes as long as M_3; cusps of same height on crest. DP_3 with short crescentic lophid on anterior moiety; crest extends anteriorly from midpoint of anterior crescentic lophid thence labially

(4) Assuming the primitive incisor formula in marsupials was $\frac{1\cdot2\cdot3\cdot4\cdot5}{1\cdot2\cdot3\cdot4\cdot5}$ and that the remaining incisors in the Macropodidae are $\frac{0\cdot2\cdot3\cdot4\cdot0}{0\cdot2\cdot0\cdot0\cdot0}$.

downward and backward along basal part of anterior moiety forming shallow basin on anterolabial corner of tooth. Lower molars longer than wide but relatively wider than in *Wallabia* and in *Protemnodon*.

DESCRIPTION.

Maxillary process opposite M^3, broad 11·5 mm. not rotated transversely, anterior lower border sharp not overturned posteriorly; infraorbital canal 24·0 mm. long, infraorbital foramen above M^1.

Teeth. $I^{2(5)}$ not as elongate anteroposteriorly as I^4, crown of enamel much longer, dimensions of crown almost uniform throughout, length of root variable from 10·0 to 20·0 mm., faint indication of groove slightly back of midpoint on lateral surface; strongly decurved; occlusion on posterior face.

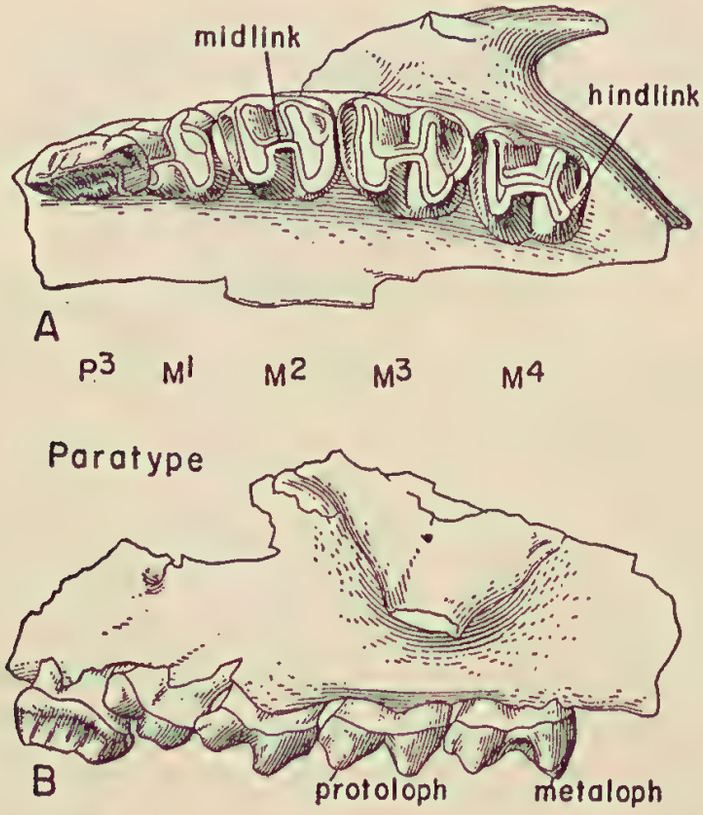

Fig. 4. *Prionotemnus palankarinnicus*, Stirton, n. gen. and n. sp., paratype, No. 44382; Woodard Locality V5367, Palankarinna fauna; Etadunna formation. Left maxillary with P^3–M^4. Occlusal (A) and labial (B) views. Natural size.

I^3 smaller in all dimensions than I^2 or I^4, labial surface convex and smooth, occlusal surface triangular in outline with posterior inflection, crown probably not more than 8·5 mm., root relatively long–9·4 mm.

I^4 crown elongate but narrow, prominent groove and ridge slightly anterior of median labial position, occlusal surface hook-shaped by anterior direction of inflection from lateral groove, crown short–9·1, root approximately 12·0 mm.

(5) This is assuming that I^1 and I^5 have been lost.

Space between alveolus of I^4 and maxillary–premaxillary suture–12·0 mm.

P^2 two wide median labial grooves and two fainter median lingual grooves separated by sharp crest; heavy basal enamel with irregular surface continuous along labial surface, not sharply differentiated into cingulum; slight lingual cingulum basal shelf with irregular surface, no lingual basin; no posterolingual cusp; anterior and posterior ends of crest only slightly elevated above middle part; labial and lingual edges nearly parallel, labial surface slightly convex and lingual surface slightly concave, angulate anteriorly; two roots.

P^3 not longer than M^3 nor shorter than M^2, four labial grooves and four lingual grooves; labial basal cingulum not continuous around posterolabial corner; irregular lingual cingulum forming narrow basal shelf and narrow lingual basin; anterior and posterior ends of crest slightly higher than three interveining cusps; prominent posterolingual cusp; tiny posteromedian fossette; replaces both P^2 and DP^3 with crest pushing up between their roots.

DP^3 molariform but with protoloph narrower than metaloph. All specimens too heavily worn to show detailed pattern.

Upper Molars. Gradation in size from large to small in upper molars M^3, M^4, M^2, M^1; M^3 and M^4 nearly equal and somewhat elongate; M^1 and M^2 nearly quadrate, M^3 and M^4 more elongate; metaloph of M^4 narrower than protoloph; prominent trenchant anterobasal cingulum nearly as wide as protoloph, not sharply deflected palinally from midpoint; no forelink; lophs crescentic in early stages of wear become less so as they wear down; midlink usually formed by spurs developed from protoloph and from metaloph, curved labially and posteriorly from protocone to middle of metaloph, curvature less apparent in later stages of wear, anterior and posterior spurs of midlink usually fused but sometimes not complete particularly in M^3; faint basal lingual cingulum sometimes present on any of the upper molars. Hindlink crescentic on M^1, M^2 and usually on M^3 joins at midpoint with similar but less distinct crest from metacone, extends to base of metacone on M^4 and sometimes on M^3.

Mandible. Symphysial region only slightly upturned in lateroventral outline, not decumbent. Mental foramen usually elongate and ovate, directed anterodorsally, near diastemal crest, distance anterior to P_3 variable (8·4–13·5). Edge of masseteric foramen between opening of posterior dental canal and coronoid fossa observable in adult specimens with mandible in horizontal position at eye level; mandibular ramus, tooth row, and symphysis nearly horizontal.

I_2 lanceolate; slightly curved from tip to end of root in labial outline; labial enamel surface and length of root about equal; enamel extends upward from ventral border nearly halfway on lingual surface; relative proportions as in *Wallabia*; length of diastem between I_2 and C in one adult–36·9.

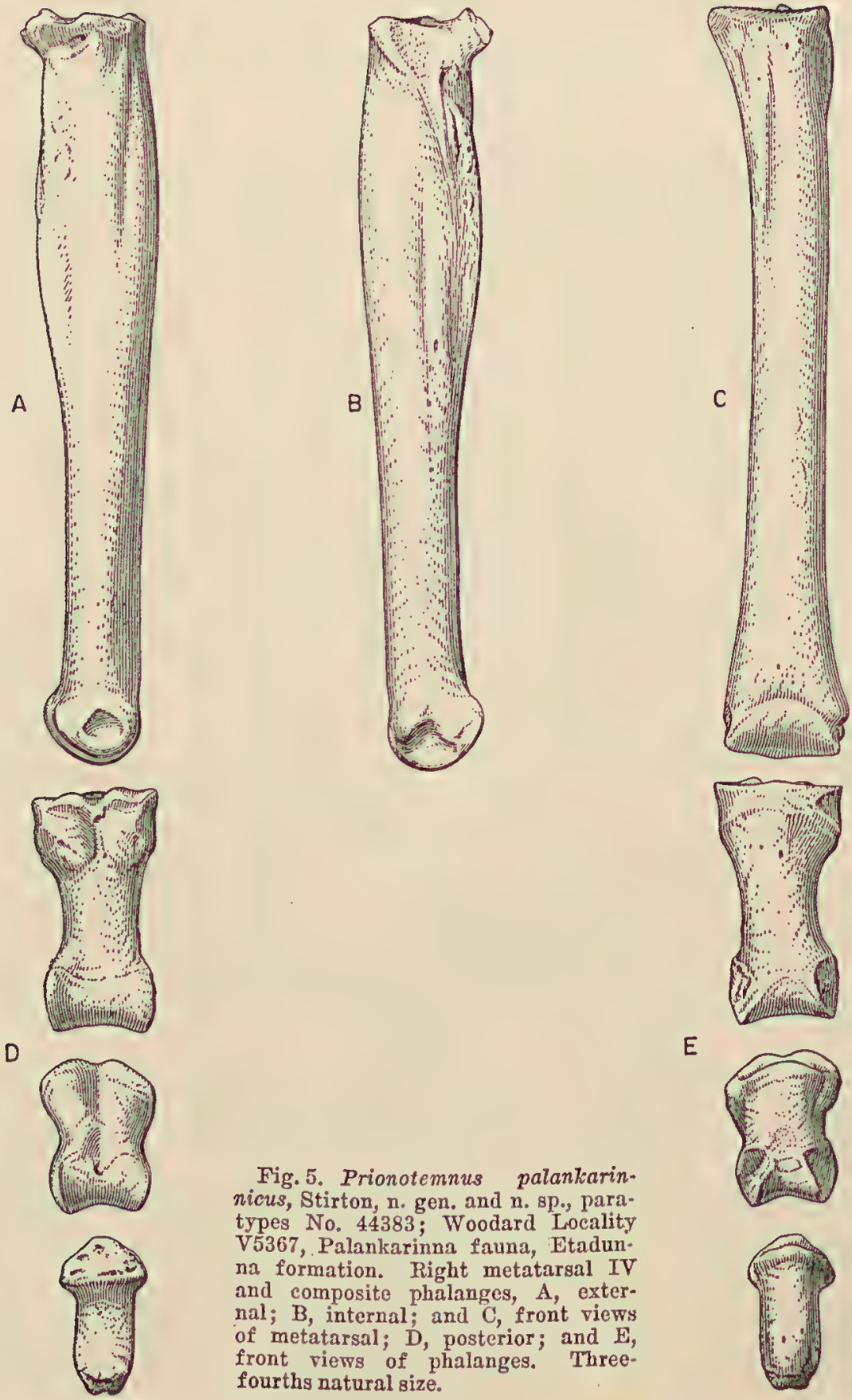

Fig. 5. *Prionotemnus palankarinnicus*, Stirton, n. gen. and n. sp., paratypes No. 44383; Woodard Locality V5367, Palankarinna fauna, Etadunna formation. Right metatarsal IV and composite phalanges, A, external; B, internal; and C, front views of metatarsal; D, posterior; and E, front views of phalanges. Three-fourths natural size.

P_2 long, deep and narrow anterior lingual groove; shorter wide posterior lingual groove, divided into three parts by two short ridges in apical area of unworn teeth; a little over half as long as P_3; apparently two median labial grooves (not clear because of wear in specimens at hand); no indication of basal cingulum; crest moderately serrate, of same height throughout; slightly convex labially, slightly concave lingually; two roots; no posterointernal cusp.

P_3 four labial and four lingual short grooves; labial and lingual cingula not continuous anteriorly or posteriorly; P_3 usually equal in length to M_2 sometimes as long as M_3; serrate crest, cusps of same height; posterior cusp thicker than those in front, slightly deflected lingually; replaces both P_2 and DP_3 with crest directly below these teeth; anterior end sometimes turned downward from rotary pressure of molars behind.

DP_3 submolariform; triangular outline; anterior moiety with short crescentic lophid, posterior moiety bicuspid; crest extends anteriorly from midpoint of anterior crescentic lophid thence labially, downward and backward along basal part of anterior moiety forming shallow lateral basin on anterolabial corner of tooth; another short cingulum extends from anterior midpoint down to anterolingual corner; posterior cingulum; lophids connected by midlink.

Lower Molars. Gradation in size of lower molars M_4, M_3, M_2, M_1; longer than wide; prominent anterior cingulum not equal to full width of tooth; lophids crescentic in early stages of wear become less so as they wear down; forelink curves slightly inward from protoconid then straight forward to anterior cingulum; midlink curves slightly inward from hypoconid then straight forward to middle base of protolophid, no spur extending posterior from protolophid; faint posterior cingulum; no labial or lingual cingula; no hindlink.

Metatarsal IV—anterior surface not conspicuously convex; posterior proximal half of shaft with rather sharp edge; outline of shaft above distal articulating surface ovate.

MEASUREMENTS OF METATARSAL AND PHALANGES.

Length M+ IV	123·2
Width proximal facet	20·3
Width distal articulating surface	19·2
Depth of shaft 90 mm. above distal end	20·2
Width of shaft 90 mm. above distal end	12·3

Remarks. *P. palankarinnicus* differs from each of the nine species from Queensland described by De Vis (1895) under the generic name *Halamaturus*. The characters examined occur both in the molars and in the premolars, yet characters based on the same structures in our series from the Woodard locality

are constant. Unfortunately neither the geographic location, the stratigraphic position, nor any indication of faunal assemblage information is available for De Vis' specimens. This of course makes a detailed comparison seem rather futile, since characters that are stable in one species are not necessarily stable in another. More than one of his types may come from one fauna. In some features the Palankarinna animals resemble the wallabies and in other characters they look like the species of *Protemnoden* from the Pleistocene. Our form may approximate a common ancestral position to these two genera. The proportions of the limb bones are suggestive of the Macropodinae.

FAMILY DIPROTODONTIDAE.

The relationships of the named genera of the Diprotodontidae are not yet known. The smaller genera referred to the Nototherinae seem to belong to two or more distinct groups, but we do not have enough information on the types and other specimens in museum collections to determine the magnitude of these differences. Lack of information on the stratigraphic position of the fossils and on the associated mammalian faunas has also been a serious handicap in interpreting their affinities. Nevertheless, certain characters seem worthy of comparison and comment at this time. It is hoped that additional discoveries in the near future will clear up the relationships of some of the named genera.

GENUS MENISCOLOPHUS[6] nov.

Type of genotypic species. Meniscolophus mawsoni[7] sp. nov.

The diagnostic characters of the genus are those of the genotypic species until other species have been described.

MENISCOLOPHUS MAWSONI sp. nov.

Holotype. Mandibles with complete little worn dentition, ascending ramus and most of angle broken off. Left maxillary[8] fragment with M^2 and M^3 and a right M^3 (Fig. 7, 8, 9). U.C. No. 44397.

Generic diagnosis. Incisors not markedly procumbent nor conspicuously grooved, not caniniform; dorsal outline of incisor slightly concave. Diastemal crest between I_2 and P_3 slightly convex. Posterior end of symphysis opposite anterior moiety of M_1. Length of P_3–17·1, right P_3 4·4 greater than one-half

(6) μηνισκος, crescent; λοφος, crest.

(7) Named for Sir Douglas Mawson, Professor emeritus, Department of Geology, University of Adelaide.

(8) Evidently this belongs to the same individual as the mandible since the specimens were found in proximity in the quarry and since both upper and lower teeth are in the same stage of wear.

of length of M_1, left P_3 6·0 greater than one-half length of M_1; no indication of cingulum on anterolabial corner of P_3. Length, width and height (of protolophid from base of enamel below metaconid) of M_4=37·1×26·3×20·9. Lophids of molars slightly crescentic and slightly oblique, midlink not entering into crescentic outline of hypholophid; midlink extends straight forward down into median valley from middle of labial half of hypolophid. No paralophid. Posterior cingulum elevated sharply at midpoint, shallow somewhat widened trench between cingulum and main body of tooth blocked by short low anterior directed ridge at that point. Prominent diagastric process and postdiagastric sulcus on posterior lower border of mandible.

DESCRIPTION.

Mandible. Symphysial region normal, not spatulate nor abruptly upturned; symphysial sulcus markedly U-shaped laterally, slightly convex anteroposteriorly on lingual surface along symphysial suture, narrow (1·5 wide) deep groove along symphysial line fades out 19·0 back of incisor alveolar border; ventral surface also with grooved sutural line, 39·5 this groove expands into elongate (41·7) relatively narrow (10·0) slightly depressed rugose area; subalveolaris fossa distinct; spina mentalis broken off; no torsus transversus; diastemal crest between incisor and P_3 pitted and grooved; mental foramen ovate 8·5 vertically and 5·8 anteroposteriorly, 27·5 below and 8·3 anterior to P_3. Lower border of ramus slightly convex between symphysial notch and diagastric process; diagastric process prominent, pointed; long (80·0) pronounced postdiagastric sulcus between diagastric process and base of angle; angular fossa deep (approx. 16·0) and continues forward as shallower depression 70·0 beyond postdiagastric process. Posterior angular surface nearly flat, 75+ wide below condyle (broken cannot be measured accurately); only base of ascending ramus preserved, anterior border opposite anterior moiety of M_4; postalveolar shelf back of M_4 triangular, 25·0 long, with postalveolar ridge extending more or less uninterrupted to postalveolar process at edge of postdental canal. Postdental canal 9·0 in diameter, 51·0 back of and on level of upper half of M_4, canal runs under labial border of tooth row; basal part of coronoid fossa 77·0 wide and 15·0 deep.

Lower teeth. Diastem between incisors 6·0; incisors curved gently upward and slightly outward, extends 37·0 out of alveolus; anteroventral and labial surface of incisor coated with enamel, enamel extends 12·0 into alveolus, lower surface not grooved, upper lateral surface slightly grooved near contact with exposed dentine surface, dorsal surface of dentine also slightly grooved near lateral border; dentine exposed on inner and posterior surfaces, enamel occurred

on these surfaces; thick root, reduces in size at lower end, open, not compressed laterally, terminates about 20·0 back of and below mental foramen and below P_3; dental canal passes down and over labial side of open root.

Cheekteeth decrease in size from M_4 to P_3, but M_3 only slightly smaller than M_4; some cement in depressions of teeth.

P_3 moderately worn, evidently with single cusp, exposed dentine roughly triangular, expanded cingulum extending from posterolingual corner to point between roots on labial side, shallow somewhat widened trench between cingulum and main body of tooth, no indication of anterior cingulum; lingual edge straight; no indication of vertical lateral grooves dividing tooth into anterior and posterior moieties; labial enamel 2·0 thick, lingual enamel 0·5 thick; both roots curved posteriorly.

Pattern of molars alike except shelf-like cingulum structure across opening of median valley more prominent on lingual side of M_3 and M_4 and more pronounced on labial side of M_1 and M_2. Lophids slightly crescentic and slightly oblique; protolophid not higher than hypolophid. Anterior and posterior moieties about equal in width except on M_1 where anterior moiety is a bit narrower; posterior moieties on M_2, M_3 and M_4 as wide or slightly wider than anterior moieties; posterior moieties longer anteroposteriorly than anterior moieties on all of the molars. Median valleys sharply V-shaped. Posterior cingulum elevated sharply but not discontinuous at midpoint, shallow somewhat widened trench between posterior cingulum and main body of tooth blocked by low crest at that point. Midlink extends straight forward down into median valley from labial side of hypholophid. Cingula discontinuous opposite labial and lingual surfaces of protolophids and hypolophids, tend to ascend but fades out on these surfaces.

Upper teeth. Lophs crescentic and slightly oblique; anterior moiety wider than posterior moiety; median valleys sharply V-shaped; only slight elevation in area of midlink; wide anterior cingulum, without labial cusp; short cingula across lingual and labial openings of median valleys; wide posterior basal cingula. Posterior edge of jugal arch opposite anterior edge of M^3.

MEASUREMENTS.

Length from tip of incisor to posterior angular surface	350·0
Length from tip of incisor to entry of dental canal	290·7
Depth of ramus below anterior alveolus of M_1	70·0
Depth of ramus below anterior alveolus of M_3	61·0
Thickness of ramus below M_1	33·5
Length of symphysis	113·0
Depth of symphysis at midline opposite mental foramen	47·8
Diastem between incisor and P_3	62·9

Length of teeth measured at middle and on left tooth row.

P_3–M_4=150·3; P_3–M_3=113·4; P_3–M_2=77·6;
P_3–M_1=46·4; M_1–M_4=133·4; M_1–M_3=96·7;
M_1–M_2=61·0; M_2–M_4=103·9; M_2–M_3=67·9;
M_3–M_4=72·8.

Median length × width of anterior moiety × width of posterior moiety, except P_3 which is measured across the middle.

P_3=17·2×13·0; M_1=29·0×20·0; M_2=32·4×22·8;
M_3=36·4×26·0; M_4=37·1×26·3.

Height of anterior lophid from base of enamel below metaconid of M_4 20·9
Length M^2–M^3 .. .. 69·1
Median length × width of anterior moiety × width of posterior moiety.

M^2=31·6×28·0×26·4 M^3=37·0×31·1×28·6

Comparison. The generic name *Nototherium* is second only to *Diprotodon* in its frequency in the literature. Ironically though, in all probability the specific characters in the type of the genotypic species *N. mitchelli* Owen (1845, p. 223, pls. 3–4) from the "alluvial or newer tertiary deposits in the bed of the Condamine River, west of Moreton Bay," can never be recognized. If this proves to be true the name *mitchelli* must be set aside as a *nomen dubium*[9] or *nomen vanum*[9]. It seems unwise to treat the generic name in a like manner as long as there is a possibility of recognizing generic affinities of the other species with the type of the genotypic species.[10]

Owen's type of *Nototherium* is the posterior part of a left mandible with M_3 and M_4 in place but nearly all of the enamel on the teeth has been shattered and lost. The posterior lower border of the horizontal ramus is complete but the ascending ramus is broken off. Unfortunately the teeth are so badly broken an accurate determination of affinities from them will be extremely difficult. In comparing the type with other specimens in the British Museum of Natural History it was found to be more like specimen No. 43523 (Owen, 1877, pp. 289-290, pl. XLV) than any other specimen with which it was compared. Some enamel still preserved in the median valley of M_3 in the type is indicative of a V-shaped valley as in the specimen mentioned above. This feature is also found in the type of *Euryzygoma dunense* (De Vis), 1887. *Euryzygoma* agrees with the British Museum specimen No. 43523 in that the midlink on the molars is

(9) Evidently these terms are synonymous.

(10) Thus the opinion expressed by Savage (1951, p. 260, footnote 7) is followed in his treatment of the genus *Camelops*. It is appreciated though that the case of *Nototherium* differs from that of *Camelops* in that I am still not certain that the genus can be recognized in Owen's type.

continuous as a labial curvature of the hypolophid. Furthermore, *Euryzygoma* resembles Owen's type and the British Museum specimen No. 43523 in the absence of a pronounced diagastric process and postdiagastric sulcus. *N. mitchelli* differs further from *Meniscolophus* in its postalveolar process being 40·0 below the opening of the postdental canal. In both *Euryzygoma* and the referred *Nototherium,* the lophids are more obliquely crescentic than in *Meniscolophus.* In addition *Meniscolophus* differs from both of these genera in the anteroposterior direction of the midlink, and in the midpoint elevation of the posterior cingulum. V-shaped median valleys are found in all of these genera. *Euryzygoma* differs from *Meniscolophus* in its larger size, more procumbent and more pronounced lateral grooved incisors. Other features of distinction in *Euryzygoma* are seen in the posterior end of the symphysis being opposite the anterior end of M_2, in the length of P_3 which is one-half the length of M_1, and in the protolophid being 5·0 higher than on M_4 in *Meniscolophus.*

Both *Euowenia robusta* De Vis, 1891, and *Euowenia grata* (De Vis), 1887, show marked resemblances to *Meniscolophus* in the construction of the molars, in the presence of a diagastric process and a diagastric sulcus. They differ in the shape of the symphysis and in the outline and direction of the incisors. There also are minor differences in the molar patterns. The symphysis in *robusta* is long (197·2), narrow (51·8 between mental foramina), slightly upturned, and with the symphysial notch below M_2. On the other hand the symphysis is much shorter in *grata* (116·8), wider (70·1 between mental foramina), abruptly upturned and with the symphysial notch below M_1.

I designate *Euowenia robusta* De Vis, 1891, as the genotypic species since De Vis did not refer to either species as the type of his new genus. The type specimens of these two species will be described in detail at a later date by Jack T. Woods of the Queensland Museum.

Though the generic affinities of *"Nototherium" victoriae,* Owen, 1873, are not clear and it differs from *Meniscolophus* in several features it seems nearer to the Palankarinna genus than to the other genera and species. It differs from *Meniscolophus* as follows: posterior end of symphysis opposite middle of M_2. Length width and height (of protolophid from base of enamel below metaconids) of M_4=45·3×33·5×24·6 approx. Lophids transverse. Midlink not as pronounced but in same position. Diagastric prominence as long as postdiagastric sulcus. Postdental canal about on same level in relation to tooth row as in *Meniscolophus,* but separated from postalveolar shelf and postalveolar ridge by deep groove. Median valley not as sharply V-shaped. Shelf-like cingula structures across openings of median valleys of molars not prominent. Trench between posterior cingulum and main body of tooth not blocked by crest. Length M_2–M_4=122·0.

"Nototherium" tasmanicum, Scott, 1911, seems to be close to *"N." victoriae* except in the position of the foramen of the postdental canal, which is high on the ascending ramus as in the type of *"N" mitchelli.*

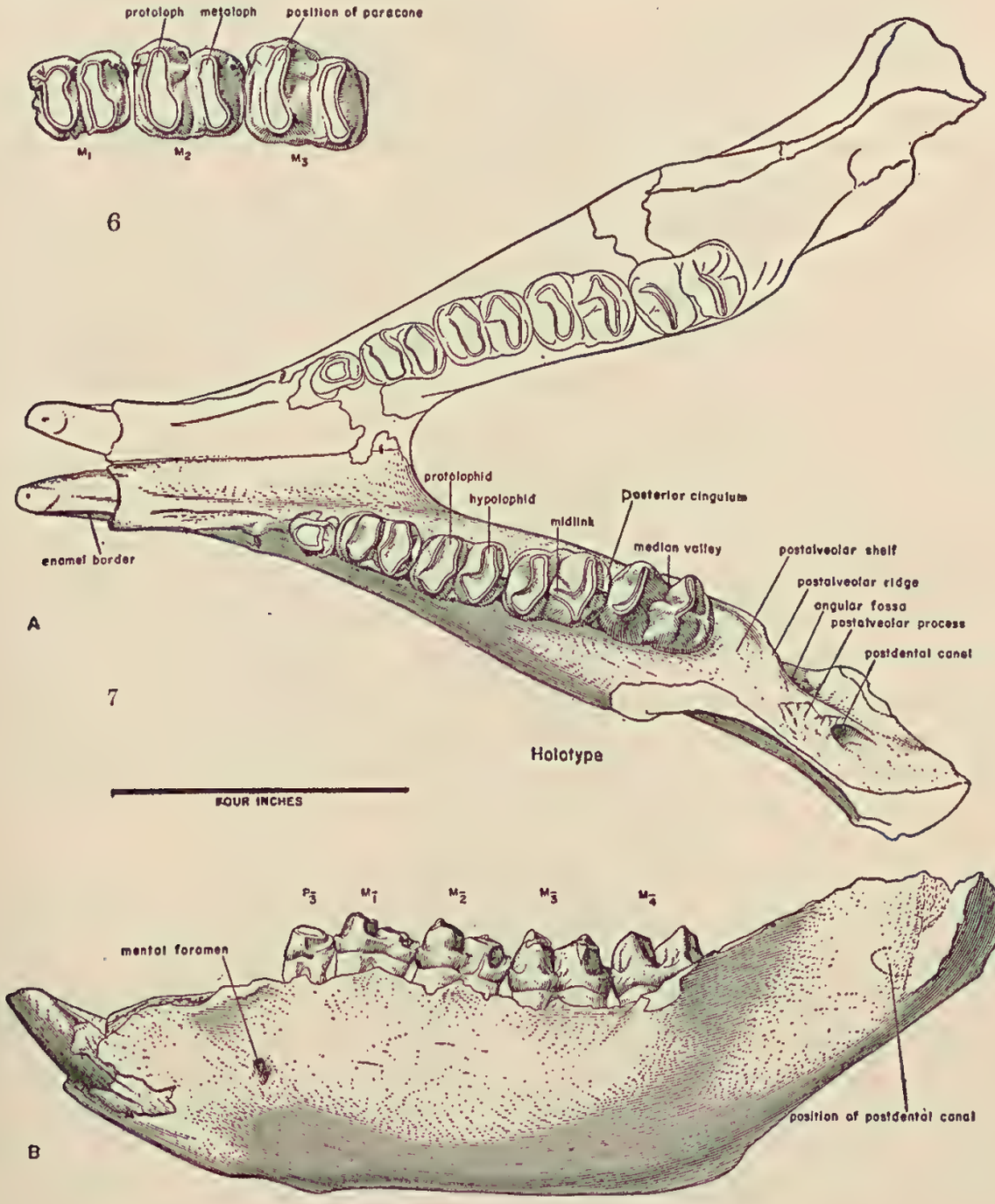

Fig. 6. Diprotodont, No. 44398; Woodard Locality V5367; Palankarinna fauna; Etadunna formation. Part of left maxillary with M^1–M^3. Occlusal view. One-third natural size.

Fig. 7. *Meniscolophus mawsoni,* Stirton, n. gen. and n. sp., holotype No. 44397. Woodard Locality V5367; Palankarinna fauna; Etadunna formation. Mandibles with little worn incisors and P_3–M_4, ascending ramus and most of angle broken off. Occlusal (A) and labial (B) views. One-third natural size.

"Nototherium" watutense, Anderson, 1937, is represented by a very poor type specimen since only a fragment of M_4 remains in part of the mandible. Nevertheless the presence of a diagastric process and a postdiagastric sulcus give evidence of a mandibular outline, at least in that area, much like that in *Meniscolophus.* Though the tooth of a possible topotype from Surprise Creek, near Wau, New Guinea (Australian Museum No. F41443), is much lower crowned and smaller than *Meniscolophus,* has median valleys not so narrow, has a much more complete anterior posterior and labial cingulum, but has slightly oblique lophids and midlinks, though not as prominent, in the same position as in *Meniscolophus, "N." watutense* is probably referable to the genus *Meniscolophus.*

It is not clear at this time to which of the smaller nototheres *Diprotodon* is most closely related. It is much larger, has a longer cranium and mandible, and the cheekteeth, though brachyodont, are both relatively and actually higher crowned. It shows a marked similarity to *Meniscolophus* in the diagastric process, in the postdiagastric sulcus, the postalveolar ridge leading from the postalveolar shelf to the postdental canal, but in other features it is not close. The large incisors have open roots; if root closure took place it must have been in the oldest individuals. On the other hand the area covered with enamel on the incisors is somewhat like that in *Meniscolophus.* The pattern of the molars in their transverse crescentic lophids, in the absence of midlinks, in the presence of cement both in the median valleys and on other surfaces of the molars, is quite different from *Meniscolophus.*

Some of the characters mentioned here may prove useful in an interpretation of phylogenetic relationships when we have more information on the Tertiary fossil record of the Diprotodontidae.

DIPROTODONT.

Four notothere specimens from Palankarinna are clearly not referable to *Meniscolophus.* These are the back part of a left mandible with a well-worn M_4 in place, U.C. No. 44401, a fragment of a left mandible with a moderately-worn M_4 (Fig. 10) U.C. No. 44390, a left maxillary fragment with M^1–M^3 moderately worn (Fig. 7), and a left M^1 of a smaller individual U.C. No. 44400 (Fig. 11). The following characters indicate affinities with part of a maxillary from the marine Miocene near Beaumaris, Victoria, but it is thought that materials from Palankarinna are not referable to the species from Victoria, though it may belong to the same genus.

Upper molars with protoloph transverse and with metaloph slightly oblique; anterior moiety wider than posterior moiety except on M^1; median valley wide; slight elevation of midlink-like structure in median valley back of

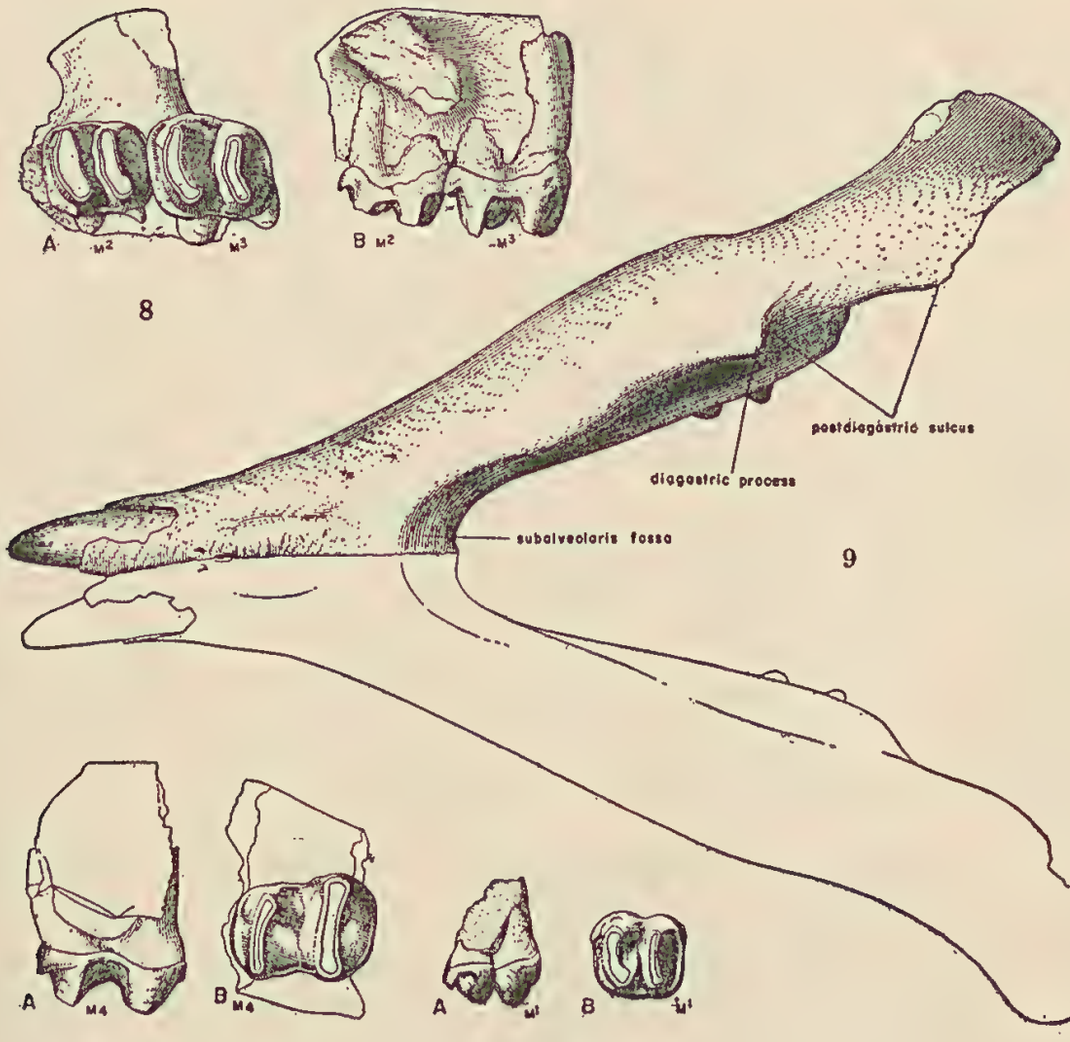

Fig. 8. *Meniscolophus mawsoni*, Stirton, n. gen. and n. sp., holotype No. 44397, Woodard Locality V5367, Palankarinna fauna; Etadunna formation. Part of left maxillary with M^2 and M^3. Occlusal (A) and labial (B) views. One-third natural size.

Fig. 9. *Meniscolophus mawsoni*, Stirton, n. gen. and n. sp., holotype No. 44397. Woodard Locality V5367; Palankarinna fauna; Etadunna formation. Mandible. Ventral view. One-third natural size.

Fig. 10. Diprotodont, No. 44397. Woodard Locality V5367; Palankarinna fauna; Etadunna formation. Right M_4. Labial (A) and occlusal (B) views. One-third natural size.

Fig. 11. Diprotodont, No. 44400. Woodard Locality V5367; Palankarinna fauna; Etadunna formation. Left M^1. Labial (A) and occlusal (B) views. One-third natural size.

paracone; wide anterior cingulum with labial cusp; wide posterior cingulum with labial cusp; short cingulum across lingual opening of median valley; stylar cusp at posterior labial base of paracone, does not cross labial opening of middle valley. Posterior edge of jugal arch opposite middle of M^3.

M_4 with transverse crescentic lophids; anterior cingulum less prominent than in upper molars; anterior moiety wider than posterior moiety; median

valley wide; slight elevation of enamel in area of midlink; no indication of cingula across opening of median valley; posterior cingulum slightly elevated at midpoint; shallow trench between posterior cingulum and main body of tooth not blocked by low crest at midpoint.

Lower mandibular outline like that in *N. mitchelli*.

MEASUREMENTS.

No. 44398.

Length M^1–M^3	109·5
Length M^1–M^2	67·9
Length M^2–M^3	80·2

No. 44398.

Median length × width of anterior moiety × width posterior moiety

M^1=31·9×27·9×28·0 M^2=37·8×33·7×31·1 M^3=43·4×36·1×32·4

No. 44400.

M^1=27·4×25·8×25·6

No. 44401.

Depth of ramus below anterior alveolus of M_1=79·0

No. 44397.

Median length × width of anterior moiety × width of posterior moiety

M_4=43·4×32·6×29·0

Comparison. The Palankarinna form is larger than the largest specimen from New Guinea (7·0 in the length of M_4) and almost twice as large as the Beaumaris specimen, from Victoria (15·6 difference in the length of M^3). Irrespective of the difference in size characters in the Palankarinna maxillary seem to be foreshadowed in the Beaumaris form except in the following features.

Posterior moiety relatively narrower transversely; anterior cingulum with labial cusp less developed but distinct; no stylar cusp at posterior labial base of paracone; posterior edge of jugal arch apparently opposite anterior edge of M^3.

If, as the evidence seems to indicate, the specimen from Beaumaris is in or near the line of ancestry to the Palankarinna diprotodont and the unit of the Sandringham sands from which it came is late Miocene in age (Singleton, 1941; Gill, 1950; Glaessner, 1951) our fauna probably belongs in the early Pliocene. On the other hand, if the Beaumaris fossil is early Pliocene (Crespin, oral communication) then our fauna could be middle Pliocene.

Unfortunately the specimens at hand offer meagre evidence for a generic diagnosis, though some of the features observed may be of generic magnitude. Nevertheless it seems expedient to await the results of another field season in anticipation of a more revealing type specimen.

TEDFORD LOCALITY[11]

FAMILY PHASCOLARCTIDAE.

Tedford discovered a fragment of a right maxillary of a koala-like animal among fragments of other vertebrates approximately 25 feet below the Woodard locality. The specimen contains the posterior border of the alveolus of P^3, the roots of M^1, M^2 with much of the enamel surface and the inner edge broken away, part of the alveolus of M^3, and the base of the jugal arch.

Though the specimen shows a marked resemblance to *Phascolarctos* it differs in several features. Anteorbital fossa shallow; width of base of jugal arch opposite M^2=6·7; enamel surface of molar conspicuously crenellated; protocone and hypocone more crescentic; M^2 as wide as long; length 6·3, width 6·3; occlusal outline of M^2 evidently more rounded.

This fossil is more closely related to the koala than to *Pseudocheirus*, *Schoinobates* or *Hemibelideus*. It differs from "*Pseudochirus* (?)" *notabilis*[12] De Vis, 1889, from Freestone Creek, Queensland, in the crenellated enamel surface of M^2, in that tooth being as wide as long, and in its more rounded outline. Perhaps additional discoveries at Lake Palankarinna will clear up the relationships of this animal.

SUMMARY.

Late Tertiary vertebrate remains are reported from the west side of Lake Palankarinna east of Lake Eyre, South Australia. The assemblage is named Palankarinna fauna. In accompanying notes the stratigraphic unit in which it occurs has been described as the Etadunna formation by G. D. Woodard. Locally the mammalian fossils are abundant in a channel deposit called the Woodard locality. The age seems to be early or middle Pliocene.

Preliminary descriptions of the mammals include: PERAMELIDAE—*Ischnodon australis* n. gen. and n. sp.; PHASCOLARCTIDAE—phascolarctid, specimen not adequate for diagnosis (found on the same level as the Woodard locality and in the Etadunna formation); MACROPODIDAE—*Prionotemnus palankarinnicus* n. gen. and n. sp.; DIPROTODONTIDAE—*Meniscolophus mawsoni* n. gen. and n. sp.; diprotodont specimens not adequate for diagnosis. Teleost, dipnoian, chelonian, crocodilian fragments and crayfish gastroliths also were found.

Ischnodon seems more closely related to the bilbies than to *Perameles* and *Thylacis* but in some features it displays relationships with these genera. The

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(11) See stratigraphic position under section on stratigraphy.

(12) This type is not referable to the genus *Pseudocheirus*, but is much closer to the koala.

phascolarctid is clearly nearer to the koala than to *Pseudocheirus, Schoinobates Hemibelideus* or *Petropseudes.* It also differs from "*Pseudocheirus* (?)" *notabilis,* De Vis, 1889, in certain details. *Prionotemnus* has some characters in common with the wallabies and others that resemble *Protemnodon.* It may represent a proximity to a common ancestor of both genera. *Meniscolophus* and the unidentified notothere share characters with most of the proposed genera and species of the Nototherinae.

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ARCHAEOLOGICAL SITE AT LAKE MENINDEE, NEW SOUTH WALES

By NORMAN B. TINDALE, ANTHROPOLOGIST, SOUTH AUSTRALIAN MUSEUM

Plate XXV and text fig. 1-12

SUMMARY

THIS paper records the details of the finding, in 1939, of a site at Lake Menindee near the River Darling in Western New South Wales, where aboriginal relics and some human remains were present in a series of three superimposed old lake-shore deposits under circumstances implying the occurrence of at least three successive industries. These have been identified, in descending order, as representing the Mudukian, Pirrian and Tartangan culture horizons.

The mammals found at the site range from extinct species of *Sthenurus, Procoptodon, Protemnodon, Sarcophilus* and *Thylacinus,* etc., at the lowest level, to a present-day fauna, it being evident that the animals were in general relics of the hunting and feeding activities of the people who made their camps there.

INTRODUCTION

During the Harvard and Adelaide Universities Anthropological Expedition, 1938–1939, while travelling by car from Broken Hill to Menindee in Western New South Wales, on 23rd June, 1939, a chance roadside delay enabled some members of the expedition to spend an hour examining the marginal shore dunes of a dry lake where the highway from Broken Hill to Menindee, dropped down on to the dry floor of Lake Menindee, at a point 12 miles north-west of Menindee township. Mineralized bones, including those of several extinct species of mammals were noted, together with aboriginal implements, on a series of wind-blown erosion areas on the high bank fronting the northern shore of the lake. Actual first find was made by Mrs. D. M. Tindale. At the conclusion of anthropometric field work at Menindee Aboriginal Station Dr. J. B. Birdsell and the writer devoted several days to an examination of the site. A general survey was made, a partial contour map being prepared with improvized instruments, and numerous specimens were collected for study. These are now registered as A. 27628–A. 28148 in the South Australian Museum. It was the intention of the team to give additional attention to the site but the commencement of the War in 1939 prevented realization of plans. A brief preliminary reference to

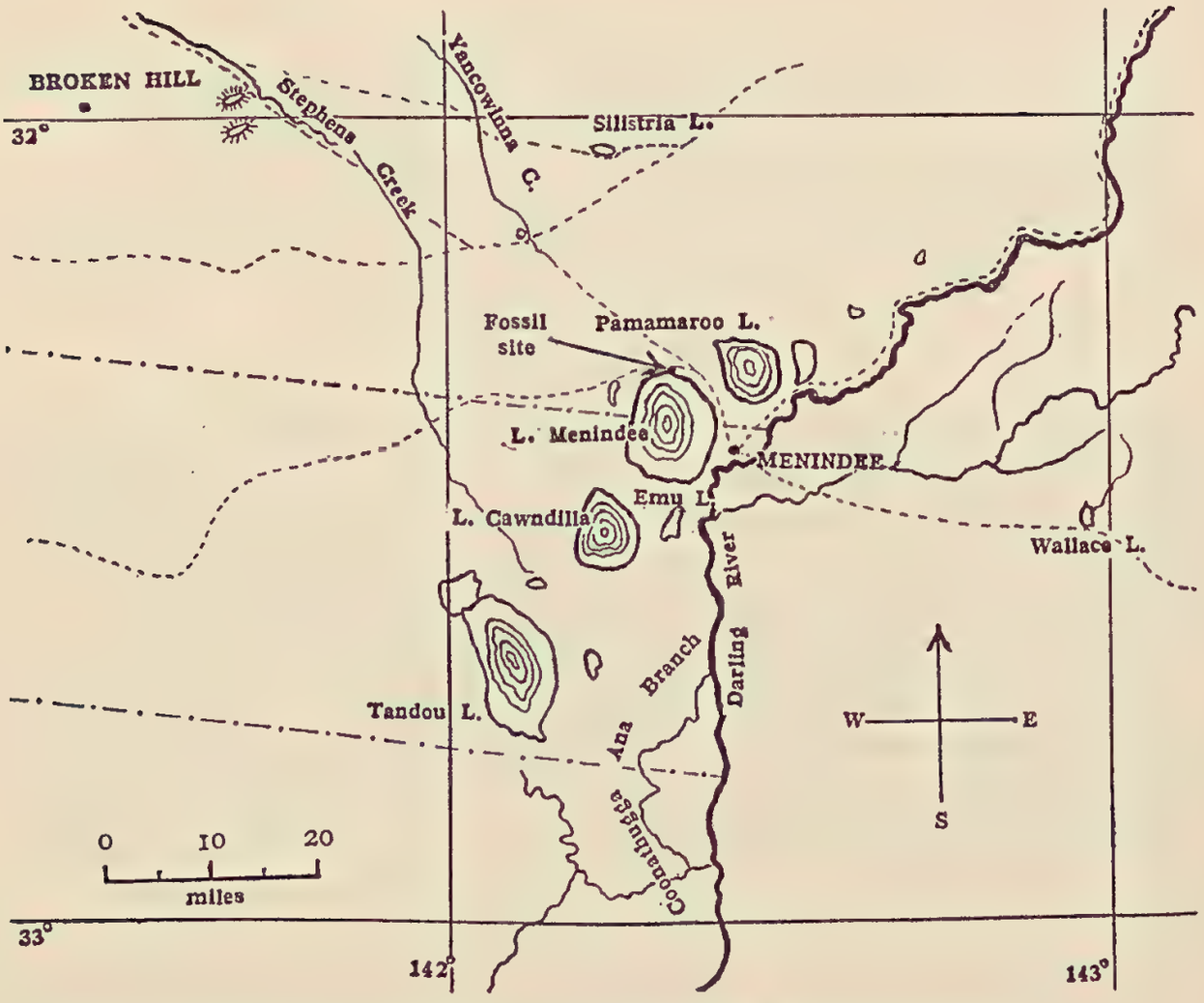

Fig. 1. Sketch map of the vicinity of Lake Menindee, Darling River, N.S.W.

the discovery was made by Dr. Hallam Movius in the Britannica Book of the Year 1940.

In March, 1953, the occasion of the visit to Adelaide of the mammalian palaeontologists, Prof. R. A. Stirton and Mr. R. H. Tedford, enabled the present writer briefly to revisit the area, and to introduce them to the array of fossil bones scattered over the area. It was then possible to check again the preliminary conclusions reached by J. B. Birdsell and the writer as a result of the 1939 work and to gather additional specimens. These also were included in the study and the following paper is a result. Prof. Stirton has given some general particulars and photographs in the journal, "Pacific Discovery", for March–April, 1954; the four illustrations on page 5 of that publication relate to the Lake Menindee site.

The identification of mammalian remains has been carried out by Mr. R. H. Tedford, who has kindly furnished a separate report on the mammal bones of Layer B.

Save some isolated human teeth gathered by Prof. Stirton from the surface of area B the human remains appear all to have been burials of bodies placed in holes in the ground in the flexed position. Thus they are transgressors in the beds to which they were introduced. Their positions furnish only limited evidence for their relationship with the other remains.

The implements and the fragmentary animal bones, being alike the waste products of camp life may tend to furnish somewhat more readily interpreted evidence as to the history of the site, and the animal bones, where they have been fragmented and burned in fire or fashioned into implements before they were buried will probably prove of the utmost significance as linking the aborigines with the mammal fauna, which they, by their continued living and hunting, doubtless helped to render extinct.

The main purpose therefore of this paper is to place on record the circumstances of the finding of the series of aboriginal remains and to discuss, in preliminary fashion, some of the cultural remains found in association with the series of animal bones. Other papers may deal in more detail with the mammalian and the human remains. A summary list of the principal human remains is given as Supplement A.

THE LAKE MENINDEE SITE

Lake Menindee is one of a series of flood basins and lake plains on the western side of the Darling River, which here flows southward as an entrenched meandering stream within a broad and mature valley many miles wide (Fig. 1). Its bed is largely cut into its own more ancient lacustrine deposits.

In 1939 Lake Menindee was, and within living memory, had been a dry plain, some miles across, with a rim of earthy sand dunes along an old lake shore. This shore was marked by a line of *Eucalyptus* trees, principally river-red-gum and box-trees.

However, in 1950 it became filled with water during the unprecedented rains of that year and in 1953 it still remained a full sheet of water in the shallow margins of which were growing many lignum bushes.

The principal fossil site is situated near the northern extremity of the Lake, just to the west of the old surveyed main road which runs from Broken Hill to Menindee. The place is near the point where the road descended from the higher plain to the floor of Lake Menindee plain. The site is about 12 miles north-west from the river township of Menindee.

Shore features of this old lake include sand dunes, some red and earthy, others of coarser and sharper sand forming a wall up to fifty feet or more in height and of a width varying from a few hundred yards to half a mile.

In 1939 the shore contours of the lake were rounded, and did not obtrude themselves, being masked by a canopy of blown sand. The advent of the water in 1950 re-established the freshness of the shoreline features and at the height of the flood nicked into and accentuated the steep sand-cliff which now fronts the area under examination. By 1953 the water was slowly subsiding, leaving the successive traces of its decline as "tide marks" along the lake shore.

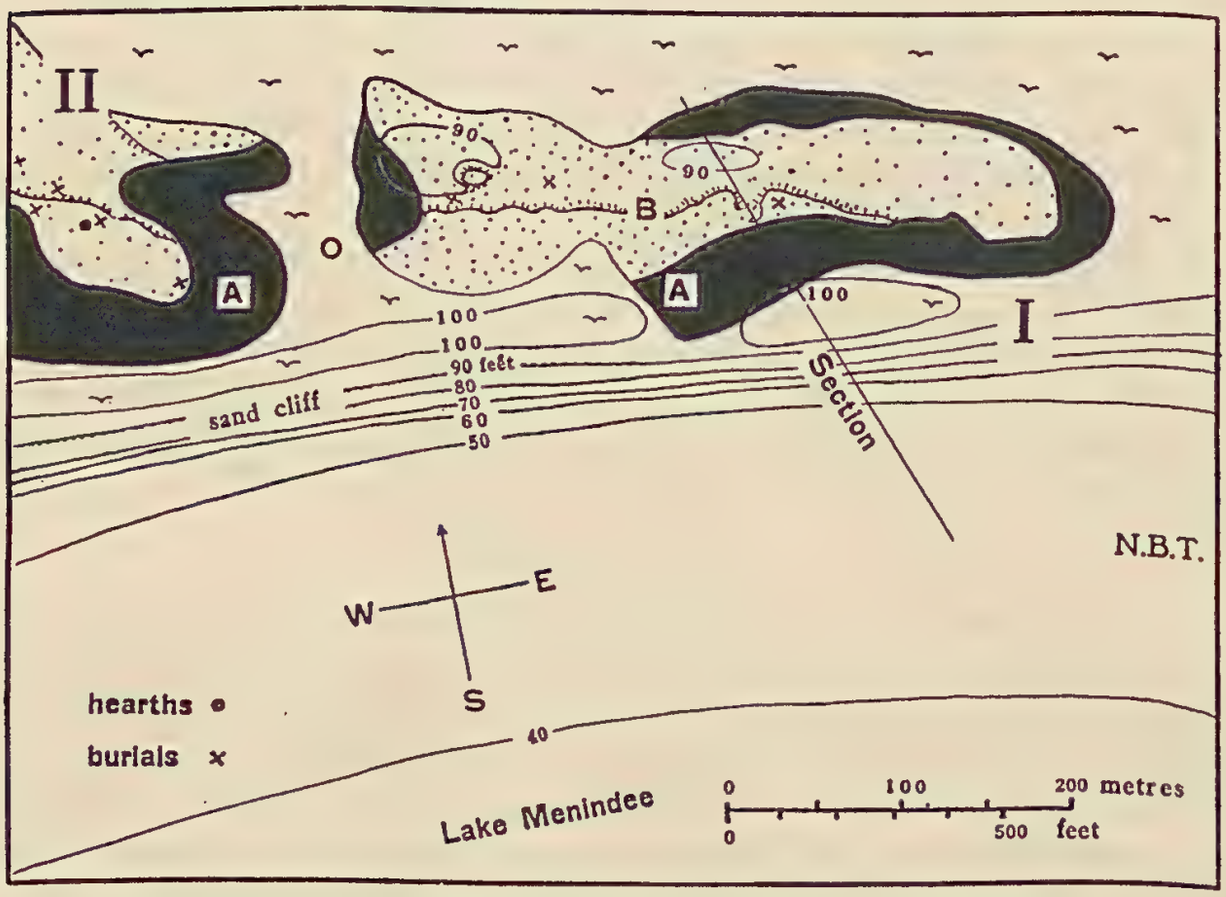

Fig. 2. Area I and part of Area II at Lake Menindee, as plotted in 1939.

During the 1939 visit to the site a survey had been made of the portions of the site that had become known to us as Area I and Area II (part only). A measured base line of 100 metres was used, together with some elementary surveying aids. A metric tape was available for linear measures but the heights were read in feet. The main features of this rough plan are reproduced as Fig. 2. The spot height of each of the major finds in the beds of Area I was noted, but as these do not furnish any particular information for this report they are not further referred to.

Contour heights were determined to a general accuracy of 0·5 foot using the highest point of the measured cross-section of the beds as an arbitrary 100-feet datum. On the basis of this datum point the "dry" lake floor near the

shore lay at forty feet or thereabouts, rising ten feet to a beach, and further as a shore cliff, some forty feet in height, to the summit of the measured section.

The shore cliff, after it became nicked at its base in 1950, was a steep very slightly indurated sand cliff, in places awkward to climb. The section, Fig. 3, shows the levels of the beds as worked out on the arbitrary scale of heights. In reproducing the plan, contours have been shown only at intervals of 10 feet although the original plotting was, in critical areas, recorded in more detail.

By 1953 shifting layers of superficial sand and further erosion had so far altered the appearance of the area that R. H. Tedford made new plans of Areas I and II on a somewhat less detailed scale and continued the mapping into Areas III and IV. The general and detailed appearance of these areas is shown in Fig. 4 which was reduced from a copy of his work plan.

THE SUCCESSION OF BEDS

Lowest and earliest bed exposed at this site is the one depicted as Layer B in the accompanying plans and section. The greatest thickness of it seen was about four feet (1·2 metres). The bed was not depthed during the course of this study. It is a buff-coloured sand containing calcareous pipes and concretions which on weathering produce a gravel of spheroidal calcareous nodules up

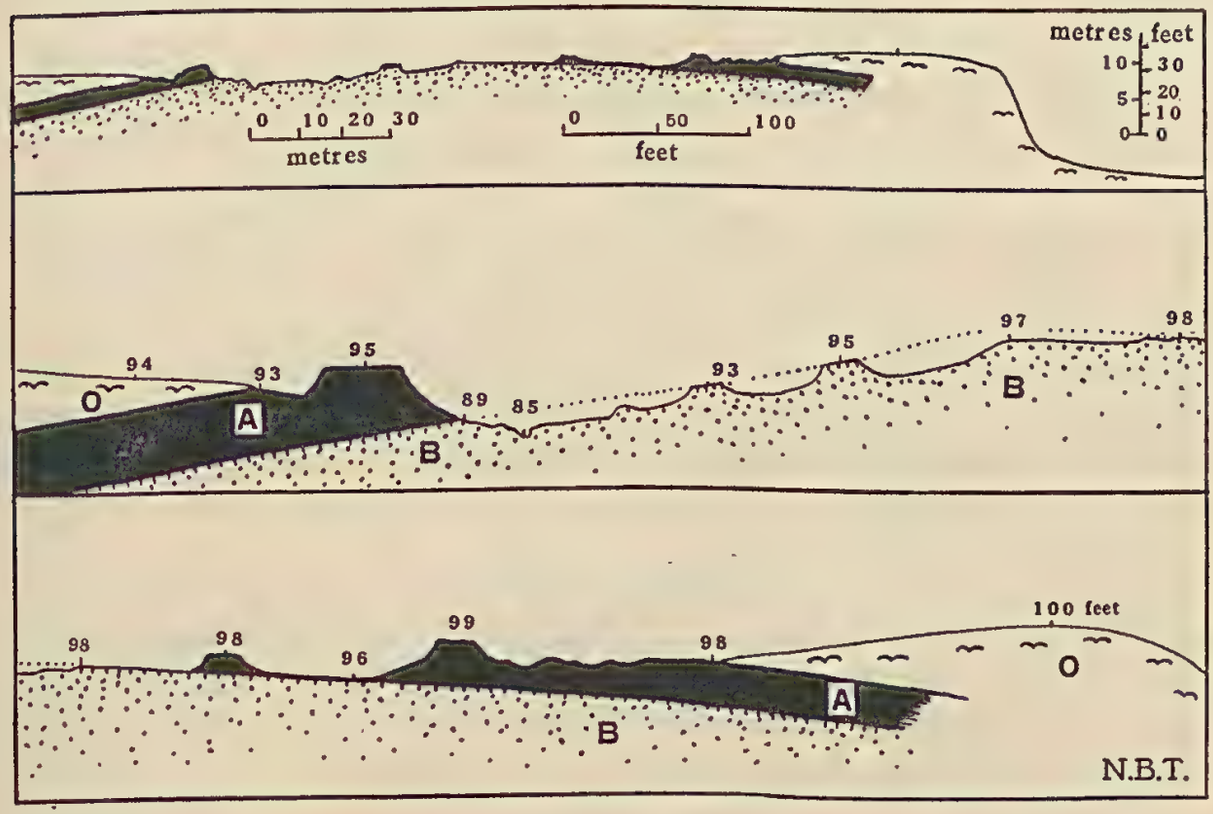

Fig. 3. Diagrammatic and detailed sections of the beds in Area I at Lake Menindee.

to 2 cm. in diameter, which everywhere characterizes Layer B exposures. The upper part of Bed B contains a slightly harder band which on weathering tends to stand up in miniature tableland formations, a foot or two above the rest of the bed and holding relatively sharp cliff edges. A minor erosional interval thus appears to have occurred between the laying down of Layer B and the appearance of a bright red silty sand bed (Layer A) lying above it. Proof of this appears to be that in more than one area the miniature erosional cliff feature of Layer B surface continues under bed A. In general the disconformity shown may be a minor one with only a moderate degree of erosion between Layers B and A.

Layer A as made known by erosional exposures varies from 2 to 4 feet (0·6–1·2 m.) in thickness. Its uppermost few centimetres tend to be grey and slightly indurated. It weathers differently from the slightly softer lowest levels of A.

In the preliminary field survey attempts were made to differentiate between an upper and a lower A layer horizon, but this yielded little additional information owing to the possibly subjective judgments necessary to prepare a good plot. On erosion Layer A does not shed any concretionary gravel residue.

The most recent bed is Layer O, lying unconformably on Layer A, and consisting of a wind-blown light red sand, coarse-grained in some areas, perhaps as a result of wind-sorting, partly held in control by dune vegetation, but merging into a drifting superficial zone denoted in the diagrams of this report by "flying bird" marks. The uppermost levels of this sand, where not fixed by vegetation, move about so relatively rapidly, under present-day conditions, that the amount of underlying beds exposed to view is subject to continual change. The different appearance thus created may be realized by trying to match the plan of Area I, as drawn in June 1939 (Fig. 2) with that done again, in somewhat less detail, by R. H. Tedford in April, 1953 (Fig. 4).

No significant differences have been detected in the beds as they reveal themselves successively in the four main areas of exposure. For the purposes of this report they are treated together although each of the specimens collected is so marked that its source can be reviewed, on an individual area basis, when this is deemed desirable.

In the gathering of the fossil and archaeological material a few general principles were borne in mind. On the one hand uneroded witnesses, or uneroded blocks of late beds, from their surfaces tend to yield only relics of late culture. The greater the degree of erosion and the larger the number of beds involved the greater the mixing with earlier culture strata.

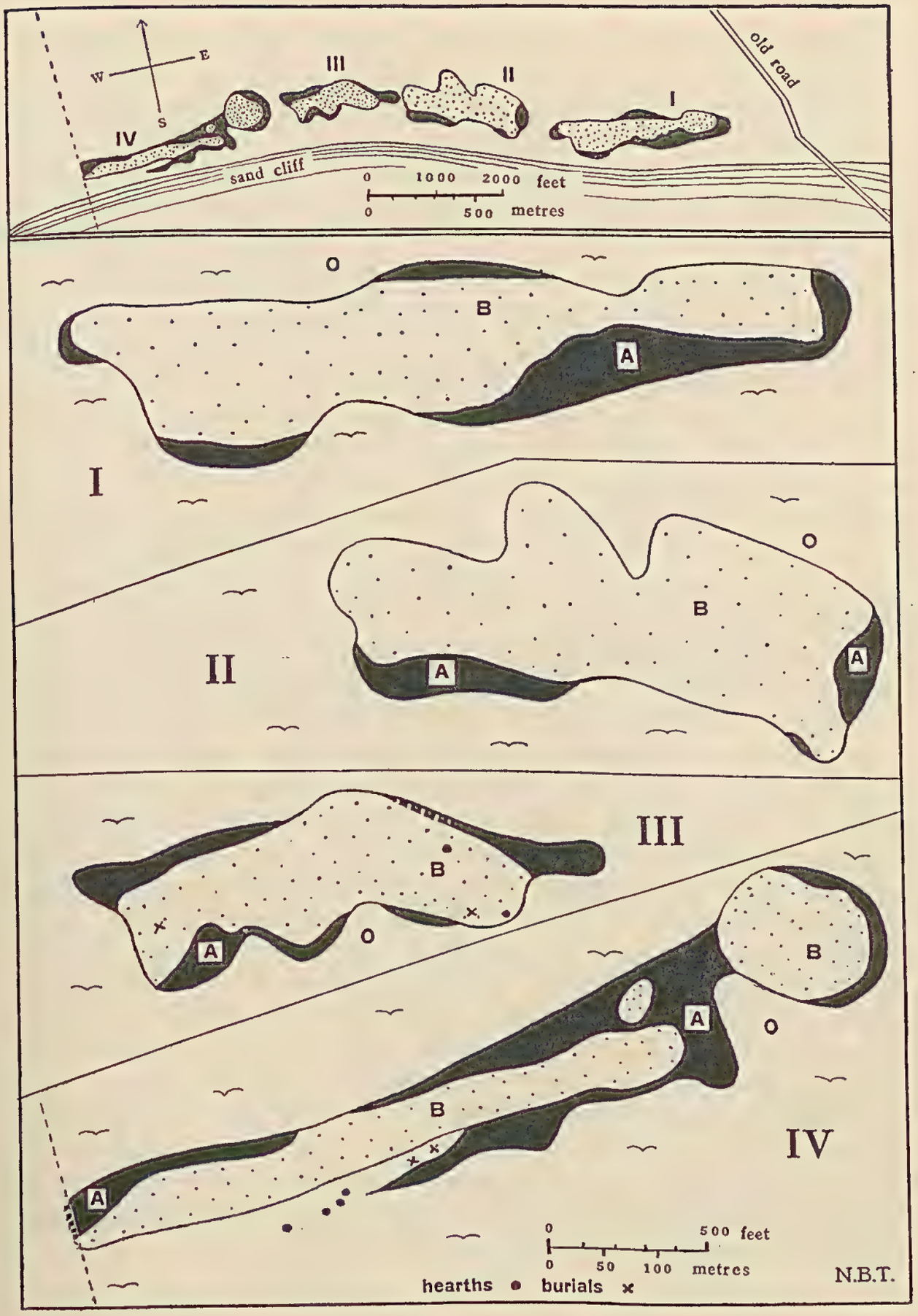

Fig. 4. Areas I–IV at Lake Menindee, as mapped by R. H. Tedford in 1953. (Positions of some hearths and burials added in Area III.)

On this criterion it was determined that microlith implement suites occurred as unmixed assemblages along with milling stones in and on the O beds and, where dropped on to A, they become mixed with *pirri* points, which joined them during the disintegration of bed A. The *pirri* implements themselves become more common as the base of A was exposed, while large semidiscoidal high-backed flake implements only became common on the top surface of B and in the erosion of B itself, where a few "horsehoof" implements also joined them.

The general impression gained thus was that the worked flake implements became larger and coarser as the beds became more eroded. This could not have been due primarily to any form of differential wind-sorting for many of the heaviest stones of all, the millstones, occurred on the uppermost deposits.

The distribution and succession of implements thus inferred led to the conclusion that, since Lake Menindee is not permanently supplied with water, a result of its periodical filling was a succession of camps made on the site, each registering a slightly different period of native culture. Since the margin of the Lake extends for many miles there may have been relatively long intervals between some successive camping episodes at a given place. The mammalian and shell remains found seem to be the food remains of these camps. They are scattered among the implements and on occasion are found broken and burned as if they have been subjected to the heat of cooking fires before being incorporated in the layers in which they had become imbedded. (Plate I h and i).

The intermittent character of the occupational deposits at the site seemed to be manifest in another way. The areas of distribution of individual camp sites tended to be less than the total area of the outcrop of the exposed beds. Camp sites in Beds O and A were not always directly above areas containing B horizon camps, so that partial separations of the implement-bearing strata were observed and the contents of the several strata could in part be isolated on such evidence. Thus it happened that in only a few places were crescent-shaped microlith implements of Layer O dropped on to the areas of B under study. In general the B camps were further away from the lake shore than sites favoured by later visitors to the site. This was possibly due to the growth lakeward of the dunes in course of time. In other places, e.g. in part of Area II, B itself was overlain by a sterile or relatively sterile bed A and from this area in particular only one *pirri* point and no crescents were recovered. The inference is that here the implements of an earlier period are present as a relatively "pure" association. Details such as this tended to support conclusions to be drawn from a more directly statistical treatment of the implements.

STONE IMPLEMENTS

The stone implements, chippings, mills and hearthstones found at Menindee Lake site are all humanly transported ones since there are no immediately available deposits of rock from which they might have been derived by natural means. Hence the few critical examples found *in situ* in the several beds seem sufficient to establish the existence of man in the area during the periods of formation of all three beds, O, A and B.

The data from buried specimens is hard to come by unless they are just beginning to be exposed, and excavations, unless on a very large scale are not likely to be very productive owing to the low degree of concentration of specimens. As illustrating this the approximately 360 specimens including bone points, studied in this paper were retrieved from a surface area estimated as some 286,000 square metres of eroding surface; in round figures this is no more than one implement on each 800 square metres of exposed surface within the area of study On such a basis the chances are unlikely of establishing implement successions by any small excavation.

The best evidence is that furnished by the limited number of specimens still remaining *in situ* in the deposits, with their substance in part revealed at the surface. A few such specimens were found and marked as in A, in B, etc. The great majority of "floating" specimens could only be recorded according to the nature of the surface on which they were recovered, as "on A," "on uneroded B," "on eroded B", "on O", etc.

On the assumption that the primary disturbing factor in this remote spot was the erosional one, which occurred only after the country was overstocked with our animals in the past half century or more, it is possible to study the distribution of the implements found on the various surfaces and to make some tentative deductions from their occurrence.

The areas of exposed surface of the beds where implements occurred were in square metres, approximately as follows:

	I	II	III	IV
O	—	—	—	est. 10,000
A	20,000	8,500	13,500	30,000
B	65,000	68,500	33,000	37,500

This is a grand total of 286,000 square metres. The implements were not generally distributed on O, somewhat more widely present on A and still more

generally distributed in areas of B. The yields can be divided on a percentage-basis as follows:

	% of implements found	% of total camp areas examined
On layer O	7	4 (based on the one camp in area IV)
On layer A	24	25
On layer B	67	71

These figures are not very satisfactory since large sterile areas of O are ignored in making the calculations. Only in Area IV was there a large camp site on Layer O.

The readily recognizable implements recovered fall into seventeen rather loosely defined categories which may serve the purpose of this analysis. Some typical examples are figured in this paper. They are ones which occurred in and on the several beds in the following proportions:

	Approximate percentages		
Implement types	On and in Bed O	On and in Bed A	On and in Bed B
Blades	6	5	7
Microlith crescents	30	4	6
Microlith discoidals	6	0	under 1
Bondi points	3	0	1
Throwing balls	3	1	1
Cores (microlith)	3	0	under 1
Millstones	18	0	3
Irregular adzes	9	3	10
Adzes, on random flakes	18	19	23
Adzes, prepared platform	0	22	11
Scrapers, core-like	3	22	17
Elouera implements	0	1	under 1
End scrapers	0	1	under 1
Points, *pirri*-form	0	18	12
Karta-like implements	0	5	4
Horsehoof cores	0	0	2
Large hand choppers	0	0	1

From this table it may be deduced that the main implement types from the three principal studied beds, O, A and B, are different. Thus, no *pirri* appear above horizon A; they are most common in and on Layer A. When the contents of A beds are "dropped" by erosion on to eroded surfaces of bed B and become

mixed with B specimens they become fewer in proportion, because of the addition of implements of different types eroded from Layer B. In the same way microliths predominate in and on eroding surfaces of bed O; when dropped on to and mixed with specimens from Layers A and B they become, percentage-wise, far less abundant. The implications of this table seem to be in line with deductions that can be made from the specimens, few in numbers, which were found *in situ* in the several beds.

The total number of stone implements on which this rough analysis was based is 344, of which Layer O contributed 33, Layer A 80, Layer B 231. The number of specimens from Layer O is meagre, but was from a well-defined campsite area in Area IV and the implements tabulated were the result of much searching on surfaces which nowhere had been eroded down to the level of Layer A.

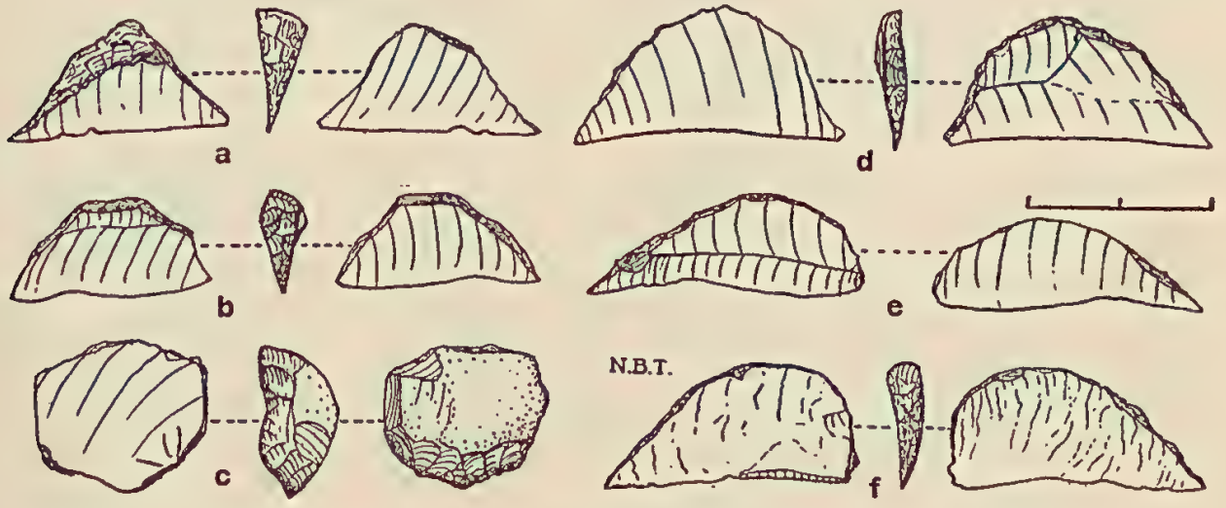

Fig. 5. Microliths from Area IV. a. triangle, b. crescent and c. discoidal adze on Layer O; d. crescent on B; e. *bondi* point on B; f. short *bondi* point, made from quartz crystal on uneroded B (natural size).

STONE IMPLEMENTS OF LAYER O

A few of the implements which appear to be characteristic of Layer O at Lake Menindee are shown in Fig. 5. They comprise crescentic and triangular microliths, some discoidal microliths and *bondi* points. Some are fashioned from a white, now slightly chalky, chert and others in fine grey quartzite, a greyish-white quartzite, and a greyish chert containing sandy nodules One *bondi* point (Fig. 5f) is very delicately worked in clear quartz crystal.

Along with these implements appear to belong adze stones made on casual flakes, such as shown in Fig. 6b.

At least a few of the "throwing stones" belong with this suite; an example is the one found on Layer O in Area IV and figured as Fig. 6a. It is made from a dull milky-white quartz. Other subspherical throwing stones were found lying on beds A and B, so that it cannot be established that such spherical

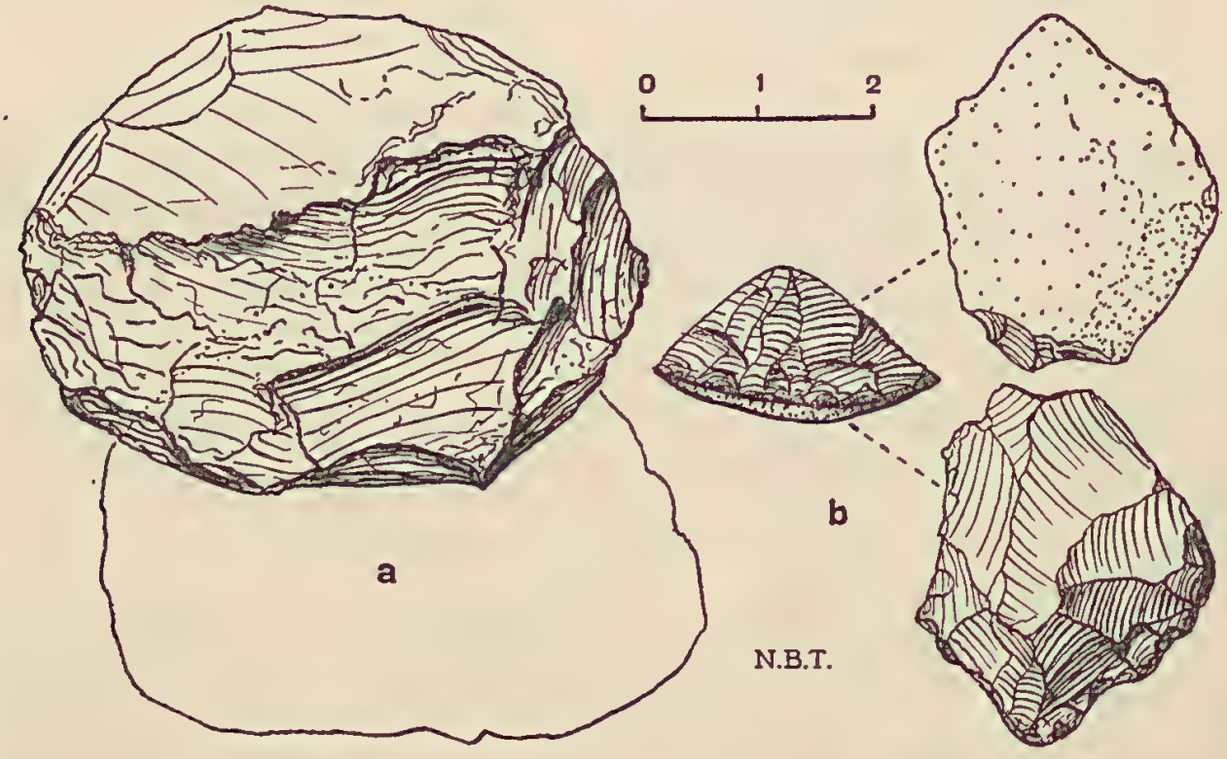

Fig. 6. Implements from Area IV. a. throwing stone of milky quartz, on Layer O; b. adze stone made from random flake, on Layer O (slightly under natural size).

trimmed stones are particularly an implement of upper horizons. However, they are known to have remained in use until modern times and an example of the implement as used by a living aboriginal of the Flinders Ranges, only some 200 miles to the west, is preserved in the South Australian Museum. Others occur in Kangaroo Island where they are associated with an industry (the Kartan) believed to be rather old.

Among known suites of implements those of this bed would best be placed with the Mudukian industry of Hale and Tindale (1930). It may be significant that the double-pointed bones, or *muduk,* characteristic of the industry at the type site, are absent. These are now known to be fishing toggles and their absence from this site could be accounted for by the absence of likely fishing sites on this shallow lake shore. The microlithic stone implement types recovered may be regarded as reliable indicators of the Mudukian industry.

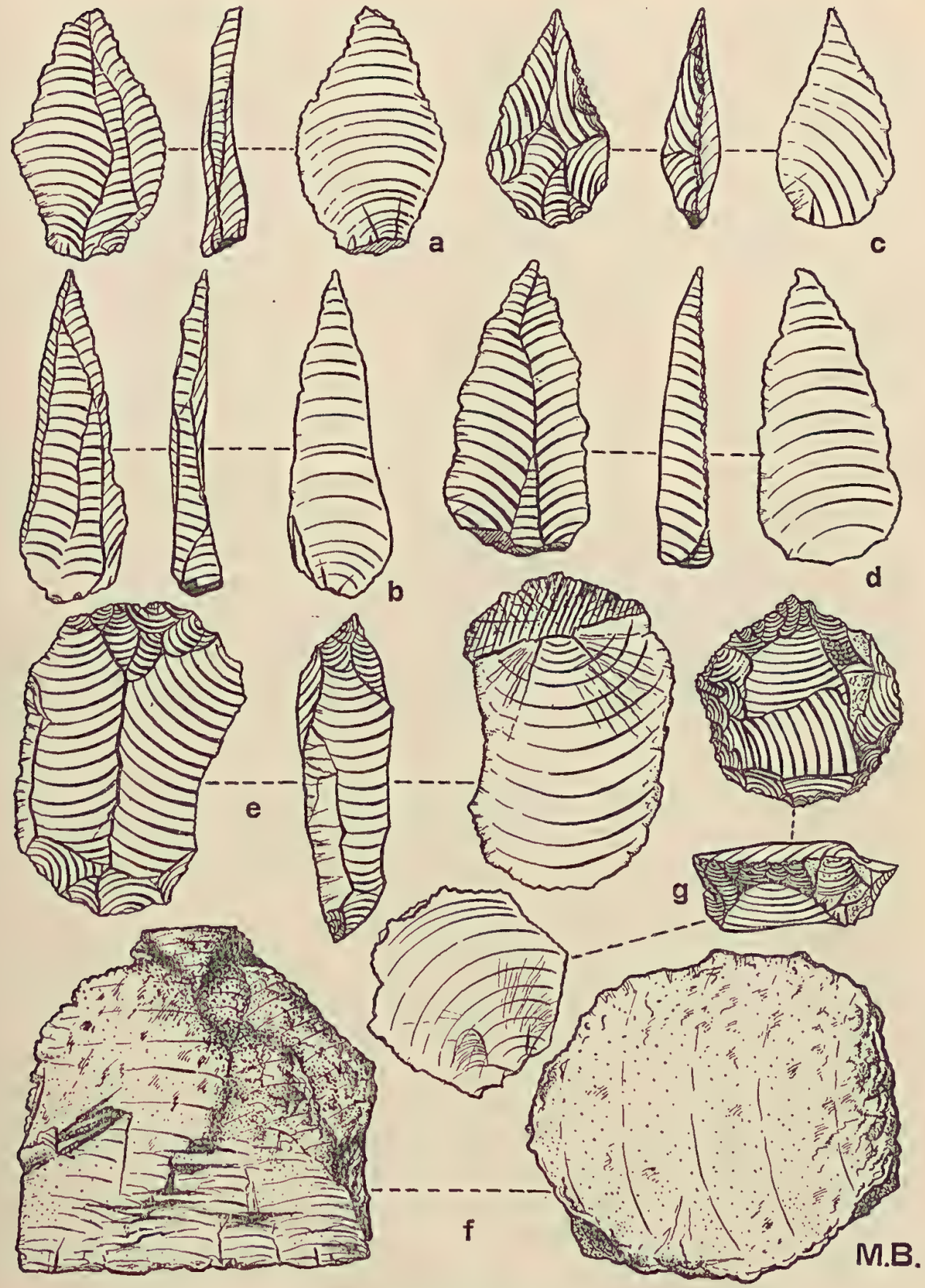

Fig. 7. Points and adze stones from Layers A and B. a. butted blade, in Layer A; b. butted blade, in Layer A; c. *pirri* point on lower part of A; d. *pirri* point on B, near a burial at Area III; e. endscraper, on A; f. high discoidal adze stone on A; g. discoidal adze stone made on random flake, found on B at Area II (all natural size).

STONE IMPLEMENTS OF LAYER A

In Fig. 7 are shown some implements which seem typical of Layer A. Projectile points of the types known as butted blades, and the developed form called *pirri* occur in and on Layer A but not in the layer above. On erosion of Layer A they are shed on to Layer B surfaces. Fig. 7a is of a specimen found *in situ* in Layer A and two others, Fig. 7b and 7c were on surfaces of A. Fig. 7d shows a specimen found on B beside the remains of a flexed burial which appeared to have been buried from a surface in A. It is not possible to establish that *pirri*-like implements do not also occur in Layer B, but on present evidence it seems reasonable to suggest that they are the most characteristic type of Layer A.

Coming also from this layer are a few end scrapers of which Fig. 7e is typical.

There are large numbers of high core-like discoidal scrapers of a type shown at Fig. 7f. This implement comprises nearly one-fourth (22%) of the artefacts of characteristic form recovered. The type is not characteristic of Layer O where the adzes are all on random flakes and much more squat in form.

Half the discoidal and other adze stones recovered on and in Layer A were ones made from flakes showing a prepared platform. These correspond to *tula* adzes and in their developed form are nearly equal to the best products of the famed Lake Eyre factory sites. Fig. 8a and d are excellent examples found on Layer A.

The balance of the adzes of Layer A are ones made on random flakes, Fig. 8b being a good example. The presence of the random flake adze is not diagnostic since it is found in all three layers appearing in increasing numbers from Layer O down to eroded Layer B.

The implement suite which emerges as characteristic of Layer A seems to be the Pirrian Industry, as defined by Hale and Tindale (1930). The projectile points are the same, as are also the very occasional *clouera*-like examples which occur. These are comparable with Fig. 195 in Hale and Tindale (1930).

There are some notable differences. At Devon Downs the few adze stones present were so worn by continued use in the manner recently described in detail by Cooper (1954), that little more than butts remained. At Lake Menindee, with sources of stone probably only a few miles removed, partly used adze stones are much more abundant and few show the great reduction which comes with long use and continued resharpening.

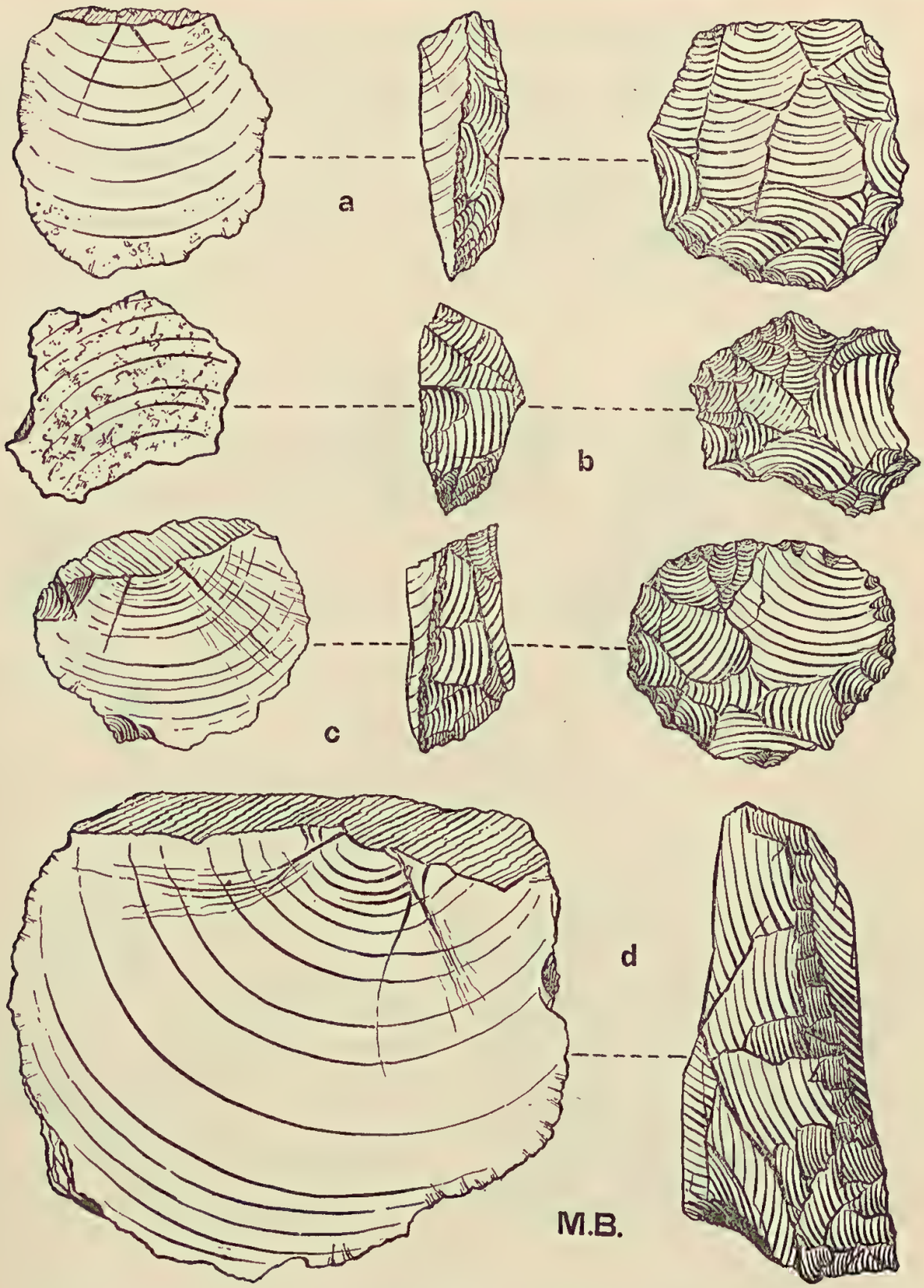

Fig. 8. Adze stones from Layers A and B. a. discoidal adze with prepared platform, found on A; b. irregular adze made from random flake, on A; c. discoidal adze with prepared platform, on B; d. large discoidal adze showing prepared platform, on A.

STONE IMPLEMENTS OF LAYER B

The only stone implements found *in situ* while excavating in B, were two flakes. One without secondary trimming was found by R. H. Tedford (his No. 38 from Area II). It has a dull white patina and is covered with the concretion of B. The other (A. 27729) was found during the 1939 visit in B at Area I. This is of a dull white patinated chert similar to several of the implements identified as of Tartangan facies.

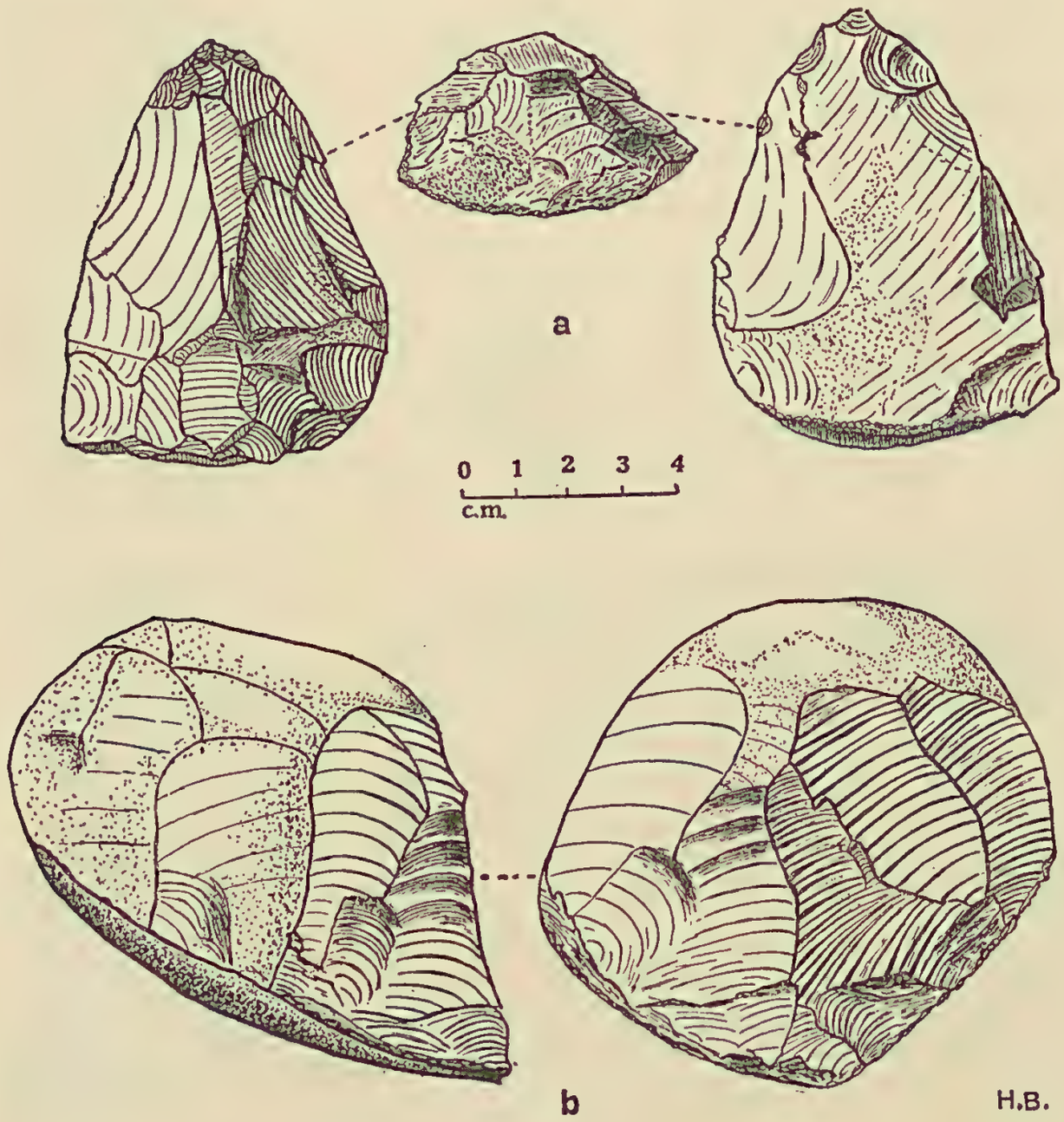

Fig. 9. a. small chopper on Layer B; b. large chopper *in situ* in a bed, identified as Layer B, two miles W. of Menindee township.

The total assembly of implements picked up on the eroded surfaces of B embraces at least some examples of each of the types characteristic of Layers O and A as well as those which might be contributions from within B, hence the assessment of what implements are from Layer B is not easy. Despite the relatively large numbers of implements retrieved from the surface of Layer B the majority of them must be ones dropped from Layers A and above; the implements belonging to Layer B are likely to be relatively few in numbers as compared with those from Layer A. However, it is not possible to clearly differentiate them, and it is only the appearance of kinds of implements not gathered from later beds which give any reliable indications.

Large "horsehoof" implements seem to be from this Layer, although one very battered one, which probably had been secondarily used as a source of flakes, was found on a B surface at a place where little or no erosion had taken place, hence presumably came from above the B horizon. Fig. 9a shows a large chert implement reminiscent of irregularly-shaped *karta* implements, and also of some of the larger implements found in the Tartangan beds by Hale and Tindale (1930). This is presumed to be a type from Layer B. Several like it were recovered from Layer B surfaces but none from the higher beds.

The finding of a rather fine hand chopper (Fig. 9b) at another site, two miles west of Menindee township, in a bed which is identified as probably equivalent to B (see notes on Other Sites, below) may tend to confirm the conclusion that large hand choppers, horsehoof implements, smaller core implements in great numbers and adze stones made on random flakes are all at home in Layer B.

These types in general are ones characteristic of sites of the Tartangan Industry, as first defined by Hale and Tindale (1930). Horsehoof implements themselves were not particularly associated with this industry at the type site but elsewhere they are quite characteristic of sites attributable to the Tartangan and earlier industries. Subject to confirmation it seems probable that men employing implements of the Tartangan Industry lived around Lake Menindee in the closing phases of the formation of Layer B and that at some time thereafter when Layer A began to be deposited they had been succeeded by people with a Pirrian Industry.

BONE IMPLEMENTS

Twenty bone implements, or pieces of them, were recovered at the site. Most of them were adrift on areas of A and B where wind erosion had exposed them; not one was found on Layer O.

Two series are evident; first those with stainings and adhesions which seem to indicate they were derived from bed A (Plate I c–g and Fig. 10 a–e) and

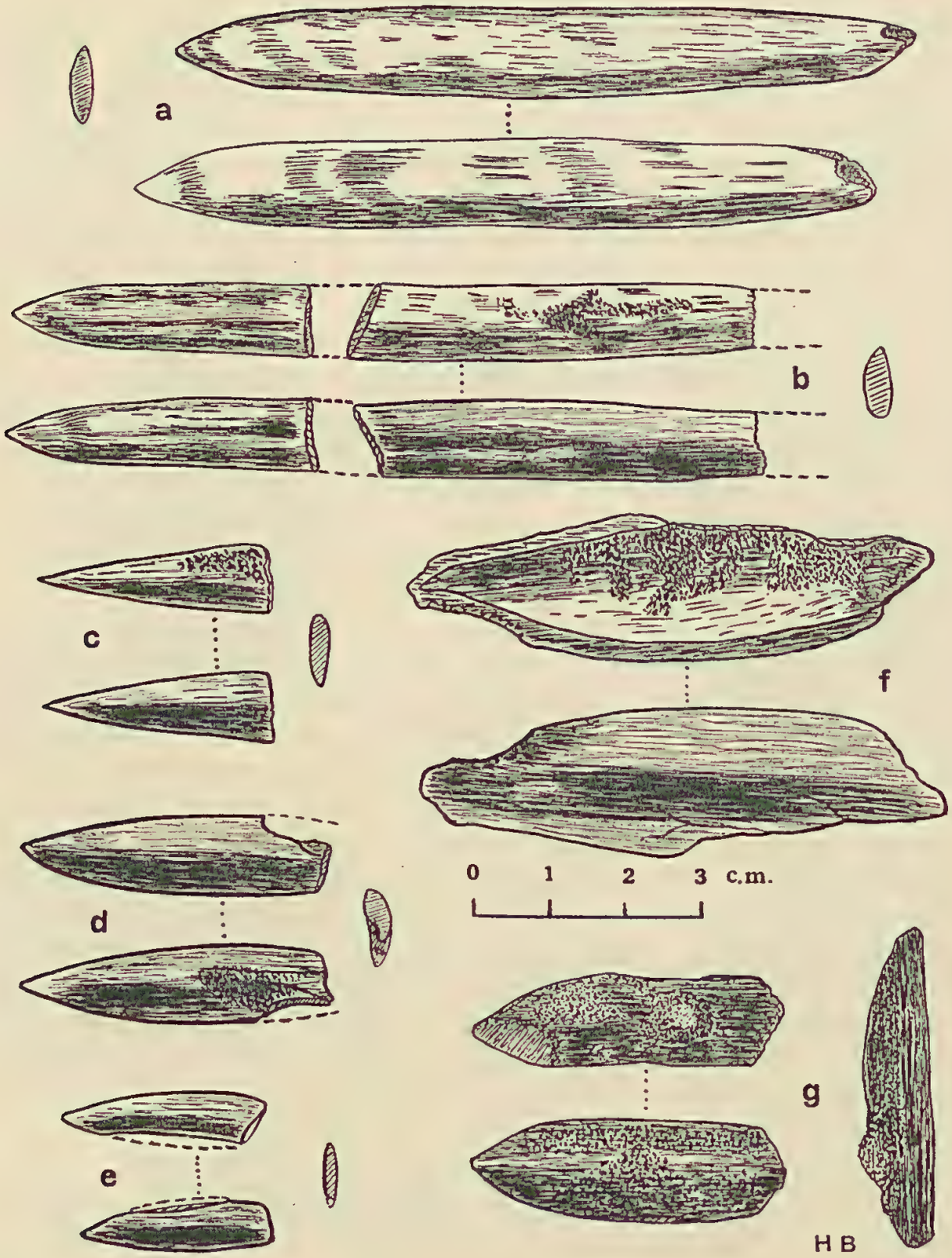

Fig. 10. Bone implements from Layers A and B. a. on B at Area III; b. on B at Area II (R.A.S. No. 4592); c. on B Area II (R.A.S. No. 4589); d. on B Area IV; e. on B Area II (part of R.A.S. No. 4589); f. on eroded B in Area I; g. in B at Area I (dotted portions represent matrix).

secondly, two examples which are from bed B. One of the latter has adhesions of B deposit (Plate I a and Fig. 10f); the other was found still *in situ* in B at a level judged to be 2 metres stratigraphically below the top of the bed. As figured (Plate I b and Fig. 10g) it still shows part of the matrix from which it was removed.

The bone implements considered to be derived from bed A are very characteristic and even the broken ones, which have snapped off, seem to have done so in a manner quite similar to ones found in Devon Downs Shelter Layers VIII-X, perhaps implying they were put to very similar uses. The two worked bones of Layer B are less easy to classify. Both are made from split pieces of massive bone and seem to have some relationship to ones found at Tartanga by Hale and Tindale (1930). It will be noted, however, that Fig. 10f bears some resemblance to the compressor-like piece of bone found in Layer IX (Pirrian Industry) at Devon Downs Shelter and figured by Hale and Tindale (1930, Fig. 224). The example found *in situ* is the pointed end of a length of massive split bone (0·5 cm. in thickness) which has been abraded to a point by rubbing in such a way as to leave two nearly flat oblique facets meeting at the outer cortex of the bone to form a point. Its general relationship might be with the bone implement from Tartangan beds figured by Hale and Tindale (1930 Fig. 24), but it is far more crudely finished.

FOOD REMAINS

The mammal remains at the site probably are in part the results of the bringing together of bodies of animals as food by the hunters who camped there. Not all are likely to be food remains since there are remains of animals which could have died there naturally. Others may have been the victims of predatory animals such as *Thylacinus* and *Sarcophilus* whose bones have been found at the site.

It is of interest to note that one of the extinct forms, *Sarcophilus*, was also found in association with Pirrian cultural remains, at Devon Downs Shelter.

No evidence of the dingo has turned up so far on the Lake Menindee site; it may have been an inhabitant of the camps of Mudukian or Pirrian times since a few limy coprolites, which could be of the dog were recovered loose on Layer B in 1939. Identifiable bone material was very scant from beds O and A. If the dog really was present perhaps the mammal bones were absent as a result of the omnivorous-eating habits of these animals which, on modern aboriginal camp-sites manage to dispose of most bone substance.

There are traces of fresh-water mussel shells *in situ* in hearths in all three of the principal beds. These shells seem to have been ones transported from the

lake as food. In general they have been subjected to fire, and hence all but a few are much disintegrated. Mr. B. C. Cotton has kindly identified the species as *Alathyria profuga,* Gould, 1851, a form which is still common in the Darling River.

Groups of shell fragments of large eggs occurred twice, both sets (A. 27920) and (A. 28103) on the surface of Layer B. Mr. Condon has studied these fragments and comments on them as follows:

A28103 consists of eleven irregular-shaped fragments, the largest 35 × 20 mm., the smallest 21 × 13 mm.; all except one have some of the matrix attached. The outer surface is smooth and unpitted, and some mineralization has occurred, but there is no trace of weathering. Thickness 1·0 mm. A27920 consists of 22 pieces, the largest 24 × 22 mm.; the other fragments are mostly smaller than those of A28103. The outer surface is smooth with some evidence of pitting. Some fragments have a dark stain, but all appear to be slightly less mineralized than A28103. Thickness 1·3 mm. A28043 is a single fragment 22 × 23 mm. and about 1·5 mm. thick. Both surfaces are covered with a limey incrustation.

In attempting to discover whether abrasion and weathering of a fresh egg of an Emu would result in a similar surface texture, an average-sized specimen, 138 × 91 mm. and 1 mm. in thickness, was rubbed with sandpaper until the coarse granulations were removed. It was found that the thickness of the shell was reduced to only 0·8–0·9 mm., and that the general texture of the shell showed little resemblance to the fragments under notice.

From comparisons made the fragments are shown to have no particular resemblance to any egg of a modern species. Curvature and thickness suggest an egg larger than that of the Emu (*Dromaius novae-hollandiae*) and it is possible that some species of fossil ratite (*Genyornis, Dromornis,* etc.) is involved.

ASSOCIATION BETWEEN EXTINCT FOSSIL MAMMALS AND ABORIGINES

The sole extinct mammal bone found *in situ* in Layer A which can be deduced as affording positive evidence of large extinct animals contemporary with people of Pirrian times is a lower jaw of *Procoptodon* with the two rami still joined together, found in a fragile state, *in situ* during the 1939 study. It is of course possible, since some erosion of bed B evidently had occurred before the deposition of bed A, that this was a disturbed fossil, brought up by accident on to Layer A, rather than an animal killed in Pirrian time. However, its presence appears significant. During the present author's second brief visit to the area part of an articulated leg which probably was that of a large bird, of the style

of *Genyornis,* was noted *in situ* in A; owing to an oversight this example was not collected by Professor Stirton's party.

The vast majority of the larger mammal bones are ones found on the surface, a few on A, usually where eroded down towards its base, but the bulk were lying on Bed B. Hence they might appear to have been contemporary principally with the relics of the implement industry here tentatively identified as Tartangan.

Burned bones were found in Bed B indicating man had subjected animal bones to fire. Plate I h shows an excellent example. The figure is of part of the right side of the rear part of a skull of the size of *Procoptodon* in the region of the orbit. This bone, its species not yet identified, was found by R. H. Tedford (his No. 62) as a loose specimen, or "float" on Layer B in Area III; it has matrix of Layer B still remaining attached, hence its horizon should not be in doubt. This matrix is posterior in time to the burning of the bone.

The presence of the bones and stone implements in apparent association in the one area could be fortuitous, and there are undoubted difficulties in the interpretation of all sites which have been exposed by wind erosion with consequent slumping of remains from one horizon to another, for despite every care in gathering the material, errors of interpretation undoubtedly can arise. Hence there is every reason to regard as tentative, the conclusion reached here, that the presence of so many animal bones together with native implements requires the particular explanation that at least some of the bones were brought together on surfaces of Layer B as food by early aboriginal hunters. The Layer B hunters seemingly left relatively few implements but many animal bones. The succeeding Pirrian people left abundant traces of occupation in the form of implements, but relatively fewer traces of the animals they hunted.

COLLECTIONS FROM OTHER SITES IN THE DISTRICT

During the 1939 visit heavy rains interrupted the field work. During interludes in the rain several sites nearer to Menindee township, on the Darling River, were examined. Beds which seemed to represent the three horizons, O, A and B were identified and further material collected. The results of these brief reconnaissances were given separate field marks in which Bed W=O, X=A and Y = B, these identifications being based on lithological similarities, which should be confirmed by further study. The principal sites were:

(a) 2 m. W. of Menindee township,
(b) 1½ m. S. of Menindee township,
(c) 1½ m. N.-W. of the Lake Menindee railroad cutting,
(d) 1⅝m. N.-W. of the Lake Menindee railroad cutting.

The "cutting" referred to is one where the railroad from Broken Hill, after skirting the shore of Lake Menindee, turns slightly to the east and cuts obliquely across the lake dunes towards Menindee township. The new (1953) highway, which avoids the Lake, instead of traversing its floor, crosses the railroad to the south side, just beyond the eastern end of this cutting.

The results of these reconnaissances yielded no data inconsistent with that from the main site. A few examples of the material therefore have been drawn to attention in the body of this paper and one specimen has been figured.

At the site $1\frac{5}{8}$ miles north-west of Lake Menindee Cutting on the windblown sand of the equivalent of the top surface of Layer O and extending slightly over on to a patch of uneroded A surface there is a Post-European campsite, possibly associated with the time of construction of the railroad. Here also were a few aboriginal hearths with some long blades, fresh wombat and rodent bones, fresh-water shells, pieces of red ochre, crude flakes and some remains of clay pipes such as were traded to and much used by aborigines in the period 1840–1880. There were neither microliths nor *pirri* implements on this site.

GENERAL DISCUSSION

The presence of several suites of implements on the Lake Menindee site which can be matched with ones from elsewhere encourages speculation as to their historical significance. In this the indications furnished by the excavations at Devon Downs and Tartanga some 300 miles downstream on the same river system are considered pertinent.

The microliths derived from Layer O are the same as those found in the Mudukian levels of Devon Downs Cave.

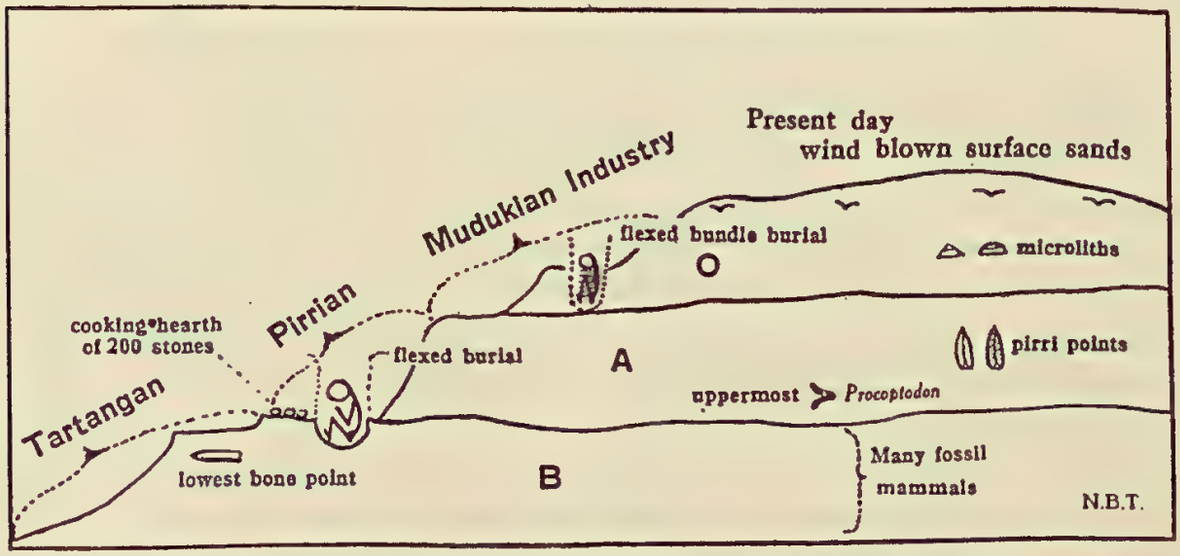

Fig. 11. Diagrammatic summary of relationships of principal finds at Lake Menindee.

The implements found in and on the eroded surfaces of A are comparable with the Pirrian Industry of Devon Downs. The suite of implements of Layer A dropped on to the uneroded surface of B may run as high as 25 per cent. in actual *pirri* implements, which would be regarded as a reasonable proportion on quite typical Pirrian sites. The relatively large implements of Layer B which appear where the bed is well exposed, seem to have affinities with those called Tartangan on the Murray River, although there are a few examples of *karta*-like implements which might be equated with the limited suites of implements of the Kartan (and allied Fulham Industry).

A generalized summary of the findings at Lake Menindee is given as Fig. 11.

The time interval involved between Layer B times and the present cannot at the moment be assessed with any great exactitude. It is hoped that some Carbon 14 determinations may soon become available for the corresponding sequences at Devon Downs and Tartanga. These may throw some light on the age of the Lake Menindee finds.

The only real clue so far available for Tartanga itself is based on the fact that the remains in the Tartangan beds became mineralized by immersion in water after they were deposited. This could have taken place during the Post-Glacial high-sea-level period, since the Tartanga site would then have been "drowned" and would have remained so through the period of high-sea levels. From this it has been deduced that Tartangan relics probably were deposited in the earlier half of the Recent Period with a terminal date indicated by Post-Glacial High Terrace time. On this basis the Pirrian culture which appears to have succeeded the Tartangan might have followed immediately after this mid-Recent episode. If this is substantiated by further work it may be possible to see the extinction of the older Australian mammal fauna as a gradual process brought about almost as much by the increasing toll of aboriginal hunters as by climatic vagaries in mid-Recent time. If the very tentative time interpretation worked out for Tartangan is applied to the Lake Menindee Site the continued presence of relics of aboriginal occupation in bed A certainly implies that any climatic changes involved during the formation of the bed were sufficiently moderate to permit of periodic returns by man to Lake Menindee, each time the lake became refilled with water, and the continued presence of man in the vicinity implies water was never very far away.

Looking further afield the evidence from Lake Menindee is in general harmony with data suggesting that the Mudukian and Pirrian Industries were widespread in parts of Australia, both along the coast and inland and that where both have occurred the Mudukian with its microliths was later in time than the Pirrian.

The particular phase of the Mudukian Industry which occurs in coastal New South Wales has been separated by McCarthy (1939, etc.) as a separate industry (the Bondaian) implying that it represented a separate coastal industry. However, typical Mudukian implements are "coastal" on the Coorong and at Penong in South Australia and the particular *bondi* points on which stress has been laid in distinguishing the coastal Bondaian Industry occur well into the interior of the continent, for examples at sites near Wiluna, at 62 miles north-west of Leonora, and at Smithsonia Waters, in Western Australia where they were found by Dr. J. B. Birdsell last year. These sites are unquestionably normal Mudukian ones. It is possible that the curious *bondi* points are really triangular needle points, used in piercing skins, when sewing them together for rugs and skin cloaks.

It is likely that in parts of eastern New South Wales as also in parts of South Western Australia and limited areas of Queensland the Mudukian (or Bondaian) was still the implement culture of the living aborigines at the time of white settlement; although it was undergoing replacement by the Murundian culture with axes, blades and crude adze flakes, it was still influenced by Mudu-

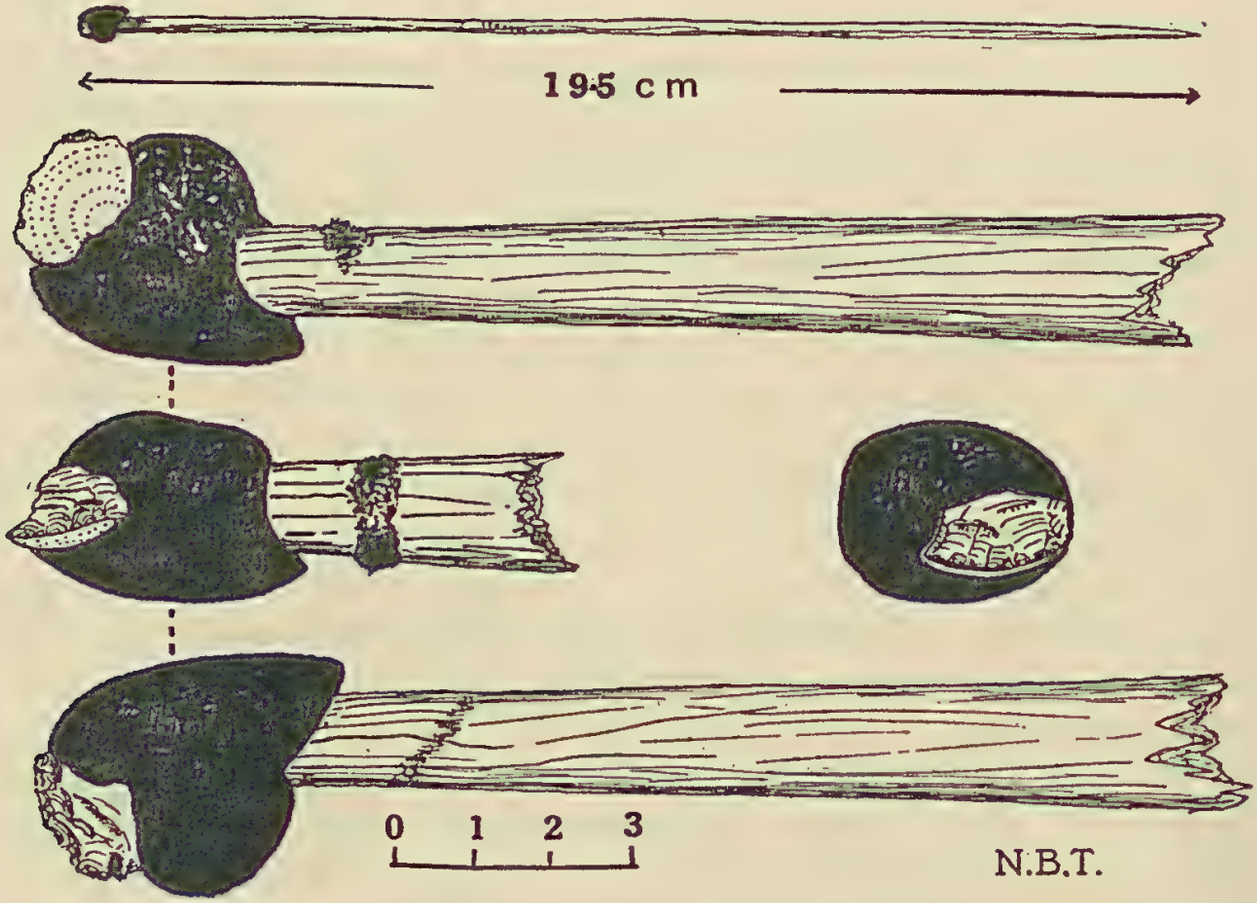

Fig. 12. Hafted microlithic discoidal adze, as used by the Maranganji natives of Beechall Creek, near Charleville, Queensland (example collected in 1886; A.31089 in S. Aust. Museum).

kian survivals. Apropos of this it seems of some little interest to note that microlithic discoidal adzes or chisels of the Mudukian culture phase survived, as functional implements, in the present-day culture of Western Queensland. There is an excellent example in our collection (Fig. 12) showing the mode of hafting employed. This adze and another were collected by Miss Dryer in 1886 from members of the Maranganji tribe at Beachall Creek (on the present Bierbank Station, 75 miles west south-west of Charleville). The second example, from the same place, lacks the stone but retains the impression of the butt of the microlith in the gum of the haft. Tests have shown that the long, slender handle (19·5 centimetres) provided exceptional control and balance for the adze, which seemingly could serve equally well as a chisel and graver in making the shallow grooves on implements, dishes and shields characteristic of the area.

The Pirrian Industry has not yet been found to occur in the coastal areas of Eastern Australia. The south-east-most localities as at present established are on the Coorong and near Mt. Gambier in South Australia and the most easterly in New South Wales is near Goondiwindi on the upper reaches of the Darling River. The westward and northern distribution of the Industry is now well established, since they have been turned up in Arnhem Land by Macintosh (1951) while Father Wurms recently has reported *pirri*-like implements from Dampier Peninsula, north of Broome. I have examined some of his specimens.

True *pirri* have been found by J. B. Birdsell and myself in the past year as occurring archaeologically over large areas in North Western Australia and the implements survived as a functional type of spear point until modern times in the Pilbara area of Western Australia, particularly among some people in the vicinity of the Hamersley Ranges. There are several hafted examples in this and other Museums which will be more fully described and discussed in a separate paper. It becomes possible to conceive that the surviving implement culture in some parts of Western Australia to-day is Pirrian and that further north the projectile point element of the industry evolved into the pressure-flaked spear point of the Worora, Ungarinjin, Djaru, Kitja and Wandjira tribe-people of North Western Australia. We have an archaeological sequence at Moola Bulla, North Western Australia, which substantiates this.

Notably missing from among the implements recovered at Lake Menindee are forms of edge-ground stone axe. This lack may have been fortuitous, but a relatively large area was searched and the absence is perhaps significant. It seems to be in line with indications at Tartanga and Devon Downs, admittedly on the very periphery of distribution of axes, that Mudukian microlithic sites lack edge-ground axes, which appear only in the subsequent Murundian horizon, perhaps indicating a late arrival of the edge-ground axe in this part of Australia.

The supposed "throwing stones" found at Lake Menindee are similar to ones found elsewhere in Southern Australia, both as to dimensions and weights. In the living culture their function is a known one as indicated by the general name, "throwing stone" applied to them. Their distribution, etc., is to be the subject of a separate paper. A Wailpi tribe term for them is ['mara] which elsewhere is a root-word for "hand". Fig. 6a shows a subspherical example of such a *mara* in milky quartz, which weighs 137 grams. This weight is slightly less than the mean of those in our collection.

The filling of Lake Menindee occurred in 1950 after phenomenal rains in Queensland and Northern New South Wales. Mr. B. Mason, of the Commonwealth Meteorological Service has kindly supplied some notes on this unusual happening:

"The year 1949 was wet in Queensland and New South Wales. Every river in both States was in flood. By the end of the year all the catchment areas of the Darling River showed rain records 20 to 30 per cent. above average. The year 1950 was even wetter, and by the end of the year all districts had had from two to two-and-one-half times their normal rainfall.

"In 1950 Darling River floods reached Menindee in April and by the end of the month the mark was 9 inches above flood level. It continued so for 13 months. Peak of the flood level, at 9 feet 4 inches was at the end of October, 1950. The long continuous period of flooding was most unusual.

"Records show that rainfall conditions similar to those which filled Lake Menindee in 1950, forcing the deviation of the old road across its bed, occurred in 1879 and 1890. There is evidently a lip over which the waters spill into the lake only at the highest flood level. There were lesser floods in the Darling in 1903 and 1921. The only other indications of unusual rainfall which might have a bearing, is the legendary account, from the coast of northern New South Wales, of very heavy rains at the end of the 18th century."

ACKNOWLEDGMENTS

The field work of the Harvard and Adelaide Universities Anthropological Expedition of 1938–39 was made possible by grants from the South Australian Government, the Carnegie Corporation of New York, the University of Adelaide and the Board of the South Australian Museum.

The field work described in this paper was done in company with Dr. J. B. Birdsell. Although his name does not appear as co-author much of the spade work was shared with him and full acknowledgment is made of his contribution to the work. The implications of the finds were discussed with him and the

appearance of this paper is in no small measure a tribute to his encouragement. Nevertheless, any errors in it are to be attributed to the present author.

The second visit to Lake Menindee was made possible through Prof. R. A. Stirton, who devoted part of a grant-in-aid from the Associates in Tropical Biography, University of California, to the journey. He and Mr. R. H. Tedford obtained additional material as well as many mammal bones for study. Mr. R. H. Tedford supplied identifications of mammals.

Mr. B. Mason, of the Commonwealth Meteorological Service, provided data on the phenomenal rains which filled Lake Menindee in 1950. Mr. H. Condon kindly examined some remains of eggs, and the identification of the fresh water shells was made by Mr. B. C. Cotton. Miss M. Boyce and Mr. H. Burrows are responsible for some of the drawings illustrating this paper; warm appreciation is expressed for their contributions.

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DESCRIPTION OF PLATE XXV.

a. Possible bone compressor on eroded B in Area I; with adhering matrix of B.

b. Bone point found in B on Area I with some matrix still retained on it.

c-d. Tips of pointed bones, found on B in Area II (R.A.S. No. 4589); show adhering particles of Layer A.

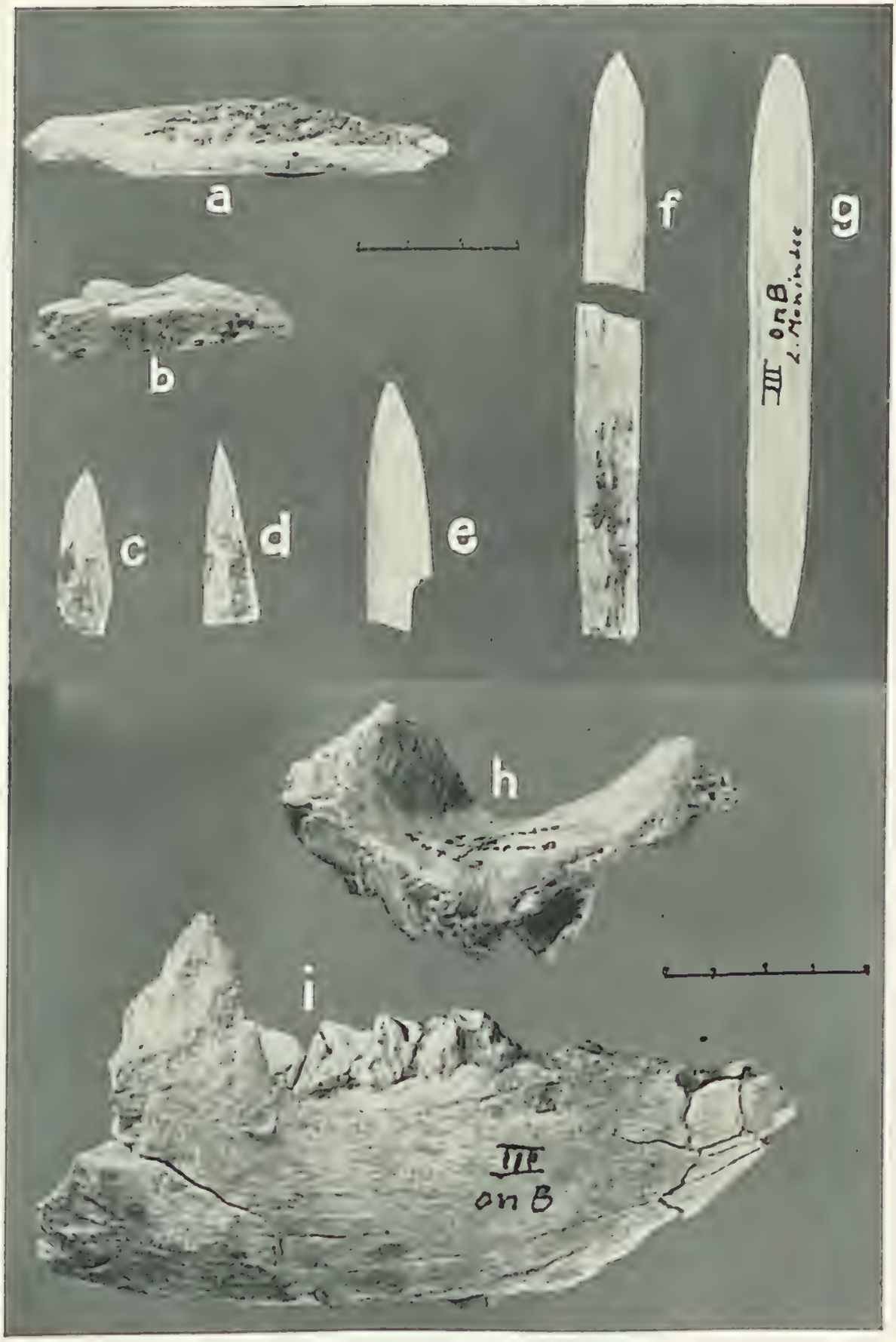
e. Tip of implement on B in Area IV.

f. Two parts of bone implement, on B in Area II (R.A.S. No. 4592); shows matrix of Layer A.

g. Complete bone implement on B in Area III.

h. Burnt bone with incrustation of Layer B found on B in Area IV (R.H.T. No. 62).

i. Typical jaw fragment showing probable traces of burning; on Layer B in Area III.



BONE REMAINS FROM MENINDEE.

SUPPLEMENT A.

THE HUMAN REMAINS.

The principal human remains found in 1939 are listed below. No attempt has been made to study them.

A.27712 was a partly mineralized human skeleton found at Area I in a circular pit dug through the lower part of A into Layer B, and situated immediately to the east of the measured section. The hole contained the soil of Layer A, indicating burial from a horizon in the upper part of A. The burial was in a flexed position, having been buried in the upright squatting position, pelvis to the north-east and knees to the south-west. Only the lower part of the trunk was *in situ*; the bones of the upper half of the body had partly disintegrated and were scattered over the adjacent eroded surface of B.

A.27759 comprised parts of an incomplete skeleton lying at the junction of A and B beds in Area II.

A.27763 consisted of bones of at least two persons lying on the surface of scarcely eroded B near to a hearth on the uneroded top surface of B. This hearth was *in situ* and fashioned from many transported stones. (A photograph suggests over 200 stones were present.)

A.27770 was the burial of a child lying on an eroded surface of B at the western end of Area III (approximately at the position shown with a cross in the 1953 survey of Area III). The remains were spread over an area of a diameter of 3 metres. It is estimated that 0·5 m. of bed B had been eroded from the area. The child may have been buried from a horizon in A but there is no evidence to contradict an even later interment from Layer O.

A.27725 consisted of fragmentary portions of the skeleton of a child found in Area I in an eroded area 1·3 metres below the level of the upper surface of B at a point 100 metres W. of the measured section. Some of the bones seem to have adhesions of the matrix of Layer B.

A.27734 consisted of scattered human bone fragments found on the surface of B in Area I, 155 metres W. of the measured section. The bones were mixed with various mammal bones scattered over an area of 3 metres diameter. The mammal bones showed more concretionary adhesions and appeared older than the human remains.

A.27752 was a burial the bones of which were scattered widely in Area II on top surface of barely eroded bed B, being evidently derived from A or above.

A.27752 was a burial near the eastern end of Area II, the bones of which had become scattered on the top surface of slightly eroded B. Seemingly it had been

derived from A or above. A hearth in the uppermost B horizon at this point suggested occupation at an earlier period when Layer B was being formed.

A.27755 comprised parts of an adult cranial vault lying on bed B which had eroded to approximately 0·3 metres below the red A bed which was here 0·6 metre thick. Evidently the bones had weathered out from the level of top B, but must have been buried from a horizon either in A or above.

A.27757 a "floating" fragment of a right parietal on B in the centre of the blown out Area II was lying among some mammal bones (A.27758).

A.27774 was a burial in the central part of eastern end of Area II. Remains of it were spread on uneroded B.

Two burials still *in situ* were obtained by Stirton, Tedford and the writer during the 1953 visit. They were both in Area IV. The first was the bundle burial of a flexed individual (field No. 41), which was buried from a high level in Layer O into its base; a circular hole had been dug, a small amount of burned material or highly carbonized vegetable debris was in the bottom of the hole. The parcelled body had had an arm broken and passed through the pelvic girdle, before burial; there was the remains of a piece of wood over the region of the head. On the wind eroded surface of Layer O, beside this skeleton, was a white discoidal microlith. Others were found on the surface of Layer O in the vicinity; all being exposed by the blowing away of portions of Layer O. Where this Layer had been much eroded, they increased in numbers. This burial is figured at the top of page 5 in the account by Stirton (1954).

The second burial (field No. 42) was situated 8 metres S.W. of the first. The skeleton lay on its left side, knees folded at right angles to body with head pointing N.N.W. This burial was in a deposit of a coarser red sandy nature than the first and had been buried from a surface in a red earthy layer. It was demonstrated by Tedford, after the present writer had returned to Adelaide, that this red earth was Layer A, hence the strong probability exists that this burial is to be associated with the period of an upper level of bed A.

The grave earth was slightly indurated; the original burial pit was circular, 1·0 × 1·1 metres in diameter. The bones were much decayed but portions including the calvarium and the right humerus were salvaged. This find is figured on the lower part of page 5 of the account by Stirton (1954).

REPORT ON THE EXTINCT MAMMALIAN REMAINS AT LAKE MENINDEE, NEW SOUTH WALES

By RICHARD H. TEDFORD (Museum of Paleontology, University of California, Berkeley, California).

IN 1939, while engaged in the work of the Harvard-Adelaide Universities Anthropological Expedition, Dr. J. B. Birdsell, then of the Peabody Museum of Harvard University, and Mr. N. B. Tindale, representing the University of Adelaide, discovered human remains and associated extinct marsupials at Lake Menindee along the Darling River in Western New South Wales. The discovery was made in connection with other studies in the area and only a few days were available for an investigation of the site. At that time, however, these workers were able to map and make a small collection of fossil remains and a larger one of artifacts from two of the exposures as well as explore the extent of the fossiliferous deposits on the northern shore of the then dry Lake Menindee. A notice of this discovery was made by H. L. Movius in 1940. World War II interrupted further investigation planned at that time.

While in Australia in 1953 on Fulbright Awards, Prof. R. A. Stirton and the writer, representing the Museum of Paleontology of the University of California, and N. B. Tindale, representing the South Australian Museum, reopened investigation of the Lake Menindee area. The work was partially financed by the Associates in Tropical Biogeography, by the Museum of Paleontology, both of the University of California; by donation from a friend of the University; and by the South Australian Museum.

In late March of 1953, Prof. Stirton and the writer spent nearly a month in the field concentrating on the discovery site and associated areas on the northwestern shore of Lake Menindee. Tindale directed the party to the locality and remained for the first week to collect additional artifacts and review the stratigraphy of the sites investigated. Our party was fortunate in recovering a large collection of mammalian remains which are now being studied in the Museum of Paleontology at the University of California. Additional human remains and artifacts were also obtained, which are housed in the collections of the South Australian Museum. The circumstances of the finding of the site and an account of the archaeology has been published by Tindale (1954). Detailed descriptions of fossil remains and other studies will be presented in the future by Tindale and the writer. In view of the unusual interest of this occurrence to students of human prehistory it was felt that the preliminary results of field work on the

mammal remains done in 1953 should be reported at this time despite the incompleteness of the studies.

The generous assistance and encouragement provided by Mr. H. M. Hale, Director of the South Australian Museum; Mr. N. B. Tindale, of the same institution; and Prof. R. A. Stirton, Chairman of the Department of Paleontology of the University of California, is gratefully acknowledged.

LOCALITY

The sites are four wind deflation hollows or "blowouts" in the sand hills formed along the north-western shore of Lake Menindee, New South Wales, immediately west of the point at which the former main road from Broken Hill to Menindee entered the lake bottom. This road had been replaced by a new main road, the old one being unavailable, as filling of the lake in 1950 after phenomenal rains had left standing water over a considerable portion of the usually dry lake bottom.

STRATIGRAPHY

Deflation by the wind has penetrated deep enough into the sand hills to expose a series of superimposed aeolian deposits separated by erosional unconformities. The following generalized section presents the stratigraphic succession as exposed in all four of the blow-outs.

Unit	Lithology	Thickness
1. (O of Tindale paper)	Light red dune sand, active, but partially "frozen" by locally thick growths of Cane Grass (*Spinifex paradoxus*).	0–10 ft.
	Erosional Unconformity	
2. (A (upper))	Locally exposed unit of gray silty sand.	0–0·75 ft.
3. (A (lower))	Bright brick-red cross-bedded silty sand.	0–3 ft.
4. (B)	Reddish to buff cross-bedded sand containing small calcareous spheroidal to pipey sandstone concretions, and sandstone casts of roots. Base of exposed section.	6 + ft.

OCCURRENCE

Fossil remains and artifacts were collected from all of the units of the above section except the thin and locally exposed unit two. In making these collections the stratigraphic position of each specimen was recorded. Care was taken to also record the disposition of each specimen as it was desirable to know whether materials were found in place or as float on the present erosional surface of a

given unit. It is hoped that this data will allow us to assign specimens found scattered on the present erosional surface of the blow-outs to their proper stratigraphic position. This problem is a major one at the Lake Menindee sites as wind removal of the upper units has lowered fossil remains and artifacts from the upper units on to lower units. It would thus seem possible that any specimen not found *in situ* might have one of the following origins in terms of the local sequence:

(a) Contemporaneous with deposition of the unit on which it is found.

(b) Contemporaneous with the time represented by the erosional hiatus separating the unit on which it is found from the overlying unit.

(c) Contemporaneous with any of the overlying deposits or the erosional hiatuses which separate them, including that of the Recent.

Fortunately the mammalian material, the bulk of which was collected from or on the present erosional surface of unit four (B), shows clear evidence of being derived from that unit. Mammalian remains were rarely met with in the overlying units, a fact which lessens the possibility of contamination by material of origin in the overlying deposits or hiatuses. On the other hand, material on the erosion surface of unit four (B) before unit three (lower A) was deposited may be represented in our collection as float from unit four.

In contrast with the mammalian material, relatively few artifacts were found in place and as such they present considerable difficulty of interpretation. The bulk of these materials was found scattered over the present erosional surfaces of all the lithologic units except unit two. Intrusive human burials were encountered but owing to the characteristic lithology of the exposed deposits they were easily detected.

Collections from each of the four areas investigated have been retained separately although it is clear that the lithologic units can be correlated from one site to the next. The following discussion, a summary of the material taken from each of the lithologic units, assumes such a correlation is justifiable.

UNIT 1. (O)

A bundle-type human burial was collected *in situ* from this unit. Another burial of undetermined type was found intrusive into unit four from unit one. A few artifacts and bones of recent mammals were found on the present erosion surface of this unit.

UNIT 3. (A)

Two flexed human burials were found with this unit. One was confined to this unit while the other was intrusive into unit four from unit three. These

burials may be contemporaneous with unit three, or may have been made from the surface of that unit during the time represented by the erosional hiatus separating unit three from units one or two. Two partial skeletons of the rat kangaroo (*Bettongia*) were found in place in this unit. Scattered artifacts were found on the present erosion surface of this unit.

UNIT 4. (B)

This unit yielded the bulk of the mammalian remains collected at the Lake Menindee sites. Some of these were materials collected on the surface of the unit and may belong to the time interval represented by the erosional unconformity between units four and three as mentioned above. In the main, however, the bulk of the material was taken *in situ* during the active phases of our work. Many of the bones found in place were checked and cracked as if exposed to weathering for a considerable time before burial. Frequently materials in place consisted of whole or partial skeletons, usually more or less articulated. These specimens were usually well preserved, suggesting rapid burial. Complete articulated skeletons of the smaller macropodids (*Bettongia* and *Lagorchestes*), and of the monotreme (*Tachyglossus*) were found in place. Specimens of the larger kangaroos were usually scattered, but interestingly enough, nearly complete articulated feet were not uncommon. In one case parts of the broken skeleton of a giant short-faced kangaroo (*Procoptodon*) were found closely associated. The mandible of this individual was still attached to the cranium, but most of the braincase was missing. Nearby the caudal vertebrae, sacrum and pelvis were found articulated. Articulated portions of both fore and hind limbs, broken isolated limb bones, and many small bone fragments were scattered within a radius of about a yard of the cranial and caudal portions of the skeleton. In several instances large marsupial bones showed clear evidence of having been burned. Small bits of charcoal were also commonly associated with mammalian remains *in situ* in unit four.

The evidence seems highly suggestive that the fossil mammal remains collected in place from unit four represent, to a considerable extent, man's selection of the game animals of the Lake Menindee area during the time unit four was being deposited. Thus at least part of the accumulation of animal remains in this unit might be regarded as a kitchen midden built up over a period of seasons when movements of game animals brought the nomadic hunters continually back into the area.

LAKE MENINDEE ASSEMBLAGE

The mammalian remains collected *in situ* from unit four have been identified to generic level and are listed below. This group of mammals, termed the Lake Menindee assemblage, includes a somewhat selective sampling of the mammalian fauna living in the lower Darling River region during the time unit four was being deposited. Due to the fact that materials collected from the surface of unit four may actually belong to any one of the overlying units or erosional hiatuses I have included in the following faunal list only those genera that were found *in situ*.

MONOTREMATA	Tachyglossidae	*Tachyglossus*
		*(?) *Zaglossus*
MARSUPIALIA	Dasyuridae	
	Dasyurinae	*Dasyurus* s.l.
		**Sarcophilus*
	Thylacininae	**Thylacinus*
	Myrmecobiidae	(?) *Myrmecobius*
	Peramelidae	*Thylacis*
		(?) *Perameles*
		Chaeropus
		Thylacomys
	Phascolonidae	**Phascolonus*
		Lasiorhinus
	Macropodidae	
	Hypsiprymnodontinae	**Propleopus*
	Potoroinae	*Bettongia*
	Macropodinae	**Sthenurus*
		**Procoptodon*
		**Protemnodon*
		Lagorchestes
		Onychogalea
		Wallabia
		Macropus s. l.
	Diprotodontidae	**Diprotodon*
RODENTIA	Muridae	
	Murinae	various living genera
	Hydromyinae	*Hydromys*

* Indicates the genus is extinct to-day on the Australian mainland.

If the faunal list given above is compared with the list of genera of Recent mammals from the same region and allowance made for the incompleteness of the fossil representation, the Recent fauna appears as merely an impoverished remnant of the fossil assemblage. Extinction or change of range could account for

the differences. Among the genera still extant recorded in the fossil assemblage only the hairy-nosed wombat (*Lasiorhinus*) appears not to have lived in the immediate region in recent times. It occurs to-day in the general geographic proximity of Lake Menindee, along the lower Murray River, and probably enjoyed a much larger range in former times. If one excludes the mammals known to have been introduced during European colonization, the dingo stands alone in being the only member of the native Recent fauna known to have entered the area since unit four was deposited. Had these dogs been present it is difficult to see why at least some fragments of their skeleton was not preserved in deposits in which even man was represented. The absence of the dingo from the Lake Menindee assemblage is thus regarded as real until further collections demonstrate evidence to the contrary.

ENVIRONMENT AND AGE OF THE MENINDEE FAUNA

The change in the animal life of the region, as demonstrated by the comparison of the Lake Menindee assemblage and the present-day mammalian fauna from the same region, could be a result of the supposedly rigorous climatic changes that marked the end of the Pleistocene and the beginning of the Recent in Australia (for summaries of Pleistocene and Post-Pleistocene physical history see David and Browne (1950) and Fairbridge (1953)). Geological and associated studies in Australia have revealed that this climatic change involved an overall trend towards aridity broken only by minor reversals since the end of the Pleistocene. One of the results of this transition from the cool-moist conditions affecting a large part of Australia during the Last Glaciation to the warm-dry conditions of the Recent probably involved a great restriction in the large areas of suitable herbage necessary to support the diversity of late Pleistocene herbivores. Such a climatic change could have been the greatest single cause of the extinction of these forms. As we have seen from the evidence at Lake Menindee, man was a witness to this extinction. He might have accelerated the process of extinction in the case of some forms, but it seems unlikely that he played the major rôle.

Considering the above evidence, an early Recent age or at earliest late Pleistocene for the Lake Menindee assemblage seems the most reasonable inference. The study of the artifacts from the Lake Menindee sites offers evidence for close correlations with established sections on the Lower Murray River at Devon Downs and Tartanga (Hale and Tindale, 1930). The suggestion exists therefore, that the mammalian assemblage can be correlated with a known cultural sequence. Suitable carbonaceous materials on which to conduct absolute

age determinations by the carbon 14 method may be present but have not been obtained as yet on the site. If sufficient fresh water shell material can be recovered on further work it may be possible to obtain a dating.

CONCLUSIONS

The evidence gained from a preliminary study of the material collected from unit four (Layer B) at Lake Menindee suggests the following conclusions:

1. Man was a contemporary of extinct marsupials in Australia.
2. Man hunted these animals as a source of food.
3. The accumulation of animal remains in this unit probably represents a kitchen midden built up over a period of seasons when movements of game animals brought the nomadic hunters continually back into the area.
4. The dingo probably was not present in western New South Wales at the time unit four (B) was being deposited.
5. The Lake Menindee assemblage lived at a time when a more equable climate prevailed over this part of Australia, either at the close of the Pleistocene or at the beginning of the Recent.

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REVISION OF THE GHOST MOTHS
(LEPIDOPTERA HOMONEURA, FAMILY HEPIALIDAE)
PART VI

BY NORMAN B. TINDALE, B.Sc., SOUTH AUSTRALIAN MUSEUM

Plate xxvi-xxxii and text fig. 1-25

INTRODUCTION

PART V of this Revision was published in these Records, in vol. vii, 1942, pp. 151-168. The long delay in the appearance of this part was forced by six years of interruption during World War II followed by pressure of other work. Parts VII and VIII are now in preparation.

Since 1942 three other short papers, not in the series, but dealing with Hepialidae, have been published by the present author, namely, in Ann. Mag. Nat. Hist., London, ser. 12, vii, 1954, pp. 13-15 and plate; Trans. Roy. Soc. S. Aust., Adelaide, 76, 1953, pp. 77-79 and plate; Proc. Ent. Soc. Washington, 47, 1945, pp. 183-184. One earlier paper, in the South Australian Naturalist, Adelaide, 20, 1938, pp. 1-6 and plate, dealing with the life-histories of some Australian Hepialids, has not been mentioned among previous bibliographic references.

A supposed ancestral Homoneurous insect fossil was described by the author in the Proceedings of the Royal Society of Queensland, 56, 1945, pp. 37-46, as *Eoses triassica*, from the fossil insect beds of Triassic Age at Mt. Crosby, Queensland.

As already mentioned by name in previous parts of this Revision, thanks are due to many who have assisted in the studies by loan of material, etc. As the material is worked type specimens are being returned, requests being made for paratype material for the South Australian Museum collection when these are available.

Genus OXYCANUS

Australian members of this genus were discussed in Part III of the Revision; in the present account the New Guinea species are described and some additions and corrections are made to the earlier paper.

Previously eight valid species of *Oxycanus* had been recorded from New Guinea. An additional 15 are described and figured herein.

As in the case of the Australian ones, the study of the species of *Oxycanus* from New Guinea has presented no little difficulty because of the great variability of the wing markings, which in any given species may tend to run the gamut from an almost unmarked light-coloured phase, through light and dark-fasciate, and silver-spotted forms to several distinctly melanic ones. In the study and confirmation of the relationships of the Australian species long series of specimens, including intergrades between the forms, usually were available. The New Guinea species are in general relatively scantily represented in collections, hence in making some estimates of specific distinctness, experience gained in handling Australian material has had to be relied on to make up for the limited available series.

After study of the major part of the extant material it seems that the only dependable characters for specific separations are evident in the male genitalia, but times of appearance and altitude are also useful indicators. As in the Australian forms, most of the New Guinea species have limited emergence periods and their habitats also are altitudinally (hence climatically) delimited, so that, for example, a species emerging in July is in general separable from one occurring in, say, November, and one occurring at, say, 1,500 metres is not likely to be present also near sea level.

Unfortunately these seeming facts have tended to be overlooked in the past and they often run counter to earlier cabinet identifications, which often have tended to equate, say, silver-spotted forms of more than one species as one, while giving a different name in common to groups of melanic examples of more than one other species.

Unless otherwise specified, the camera-lucida sketches of genitalia illustrating this paper were drawn from two aspects, without removal of the parts, and are intended to give as much information as possible regarding the hard parts and marginal contours of the tegumen, the apices of the harpes and the shape and general size of the 8th sternite. In these sketches the body form is generalised and no allowance could be made for post-mortem changes, etc. In general, the form of the tegumen is constant for each species; the principal variations are in the number and relative sizes of the smaller spines along the tegumen; in several instances such minor differences are evident as asymmetries in the drawings.

Since this revision was ready for press, a paper by Viette (1950) has become available. In it is a proposal that some New Guinea members of this group should be placed in a separate genus *Paraoxycanus*.

Some of the material upon which this Revision is based already has been

distributed, hence a comprehensive check is not possible, but, on the available material, it would seem probable that at most *Paraoxycanus* is a valid subgeneric division which can be used for *O. novaeguineensis* and its allies. However, the advisability of using strictly genitalia characters even for subgeneric separation is also one on which there may be legitimate doubts.

The separation of a Papuan sub-region is a relatively recent episode of zoological history—hence it is not often possible to establish clear-cut generic separations in forms from this area, and it will be noticed that, in the body of this paper, there are several instances where direct comparisons are made even between New Guinea species and the more archaic forms preserved in, for example, South-Western Australia.

The case of *Paraoxycanus* may be parallel with that encountered in the genus *Oncopera,* where an essentially northern series of species were placed in the sub-genus *Paroncopera,* but the separation cannot be defined by clear-cut characters.

KEY TO THE NEW GUINEA SPECIES OF *OXYCANUS*

(based principally on male genitalia)

1. Male genitalia with teguminal margin not armed with spines ..... *fuliginosa*
   Male genitalia with teguminal margin armed with spines 2
2. Margin with main armature of seriate spines 3
   Margin with main armature not of seriate spines 11
3. Spines on nearly full length of tegumen 4
   Spines only on posterior half of tegumen .... *rileyi*
4. Posterior margin of 8th sternite convex 5
   Posterior margin of 8th sternite not convex 7
5. Teguminal contour rather even .... *postflavida*
   Teguminal contour markedly uneven 6
6. Apex of forewings subfalcate, size large .... *tamsi*
   Apex of forewings rounded, size small .... *xois*
7. Posterior margin of 8th sternite concave 8
   Posterior margin of 8th sternite not concave .... *dives*
8. Serrations of tegumen irregular in size and spacing 9
   Serrations of tegumen regular in size and spacing 10
9. Harpe with apex not dilated .... *subochracea*
   Harpe with apex dilated .... *hecabe*
10. Harpe bent over at apex .... *hecabe* f. lethe
    Harpe not bent over at apex .... *serratus*
11. Tegumen with large process, or spine, in anterior third 12
    Tegumen with large process, or spine, at or near middle 16
12. Posterior half of tegumen with seriate spines 13
    Posterior half of tegumen with irregularly spined process ..... *thasus*
13. Anterior process of tegumen with more than one tip ..... *salmonacea*
    Anterior process of tegumen with a single tip 14

14. Anterior process of tegumen not strongly bent over at tip ..... *nigripuncta*
    Anterior process of tegumen strongly bent over at tip 15
15. Anterior process of tegumen pointed vertically downwards .... *thoe*
    Anterior process of tegumen pointed obliquely forwards ..... *albostrigata*
16. Anterior half of tegumen with seriate spines .... *atrox*
    Anterior half of tegumen not armed with seriate spines 17
17. Median process of tegumen only a simple pointed spine .... *eos*
    Median process not a simple pointed spine 18
18. Median process other than a plate-like expansion 19
    Median process a plate-like expansion 20
19. Median process a broad digitiform lobe .... *perplexus*
    Median process a slender digitiform lobe .... *meeki*
20. Median process anteriorly directed .... *mayri*
    Median process posteriorly directed 21
21. Harpes slender and inflated at tip .... *discipennis*
    Harpes of normal form .... *hebe*

OXYCANUS FULIGINOSA (Rothschild)

Plate xxix, fig. 6 and text fig. 1

Porina fuliginosa Rothschild 1916, *Lepidoptera of Brit. Ornithol. Union Exped. to New Guinea*, 2, No. 15, p. 145.

Male. Antennae reddish-ochreous, slender, short, moderately pectinate with whorls of hairs. Head and thorax dark sooty brown, abdomen grayish-brown. Forewings rather uniformly dark sooty brown, roughly scaled, with traces of long yellowish hair-like scales along costa; there is a transverse series of ochreous-fuscous marginal spots, one between each vein from $\frac{4}{5}$ costa running parallel to termen and reaching inner margin just beyond one-half (in the holotype male these are slightly more evident with traces of two additional ones on discocellulars). Hindwing gray with the base only of the wing clothed in yellow-tinged hairs; hairs near inner margin darker than elsewhere. Forewing length 19 mm., expanse 42 mm.

Loc. New Guinea: Carstensz Peak, Utakwa River, 5,000-10,000 feet, February to March, 1913, A. F. R. Wollaston. Type, probably a male, in British Museum (ex Tring), also a paratype male. The type was described as a female but appears to be (without critical examination of the genitalia) a male.

The example available for detailed study is the rather worn paratype male, but a photograph of the type (pl. xxix fig. 6) is available. The figure shows the rather characteristically rounded wings, with reduced vannal area of hindwings, a rather obscure series of markings across the forewings, and the hairy clothing.

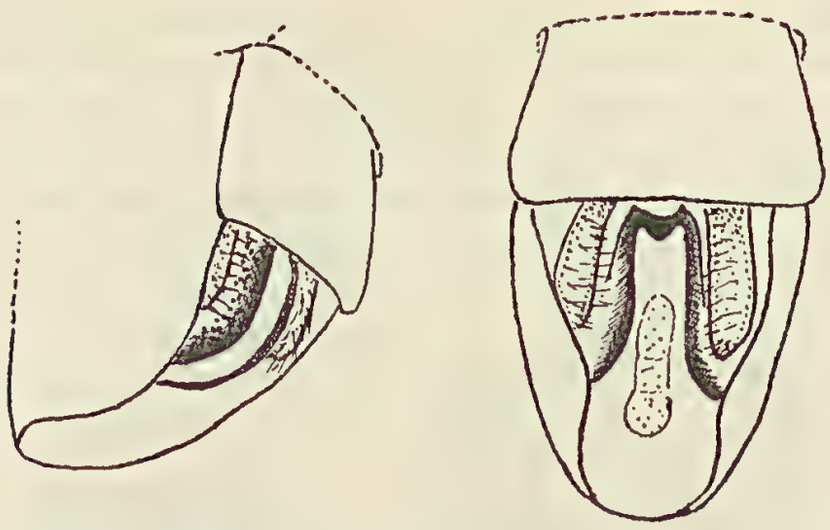


Fig. 1. *Oxycanus fuliginosa* (Rothschild), Carstensz Peak, male genitalia of paratype, oblique lateral and ventral views.

The genitalia (text fig. 1) have the tegumen entirely unarmed, presenting an even convex outline, when seen in lateral view.

This species is not close to any other known one, which is perhaps to be expected from its presence at such a relatively high altitude on a tropical mountain. The form of the genitalia may hint at relationship with the rather isolated *O. perditus* from South Western Australia, which likewise shows a tendency to reduction of the vannal area of hindwing. It is of interest to speculate that these two peripheral species may represent relict forms of a very early differentiation of the *Oxycanus* stock.

OXYCANUS RILEYI sp. nov.

Plate xxvi, fig. 1 and text fig. 2

Male. Head with antennal segments ochreous, segments transversely keeled, with whorls of fine hairs; head and thorax grayish-brown, abdomen pale gray. Forewings dark brown with tinges of ochreous brown in anterior part of disc; a broad creamy-white flash from base to termen, crossed by about eight transverse rows of silvery-white spots, each spot ringed with dark brown, cilia on termen cream, on inner margin grayish-brown. Hindwings gray with a tinge of ochreous-yellow towards termen. Forewings below gray with traces of the cream flash and the white spots. Hindwings below tinged ochreous yellow, the colour stronger along costa. Wing length 30 mm., expanse 65 mm.

Loc. New Guinea: Nomnagihé, 25 miles south of Wangaar, 2,000 feet January to February, 1921, collected by C., F. and J. Pratt. Type in British Museum (Joicey Coll., 1929-122).

Only a single example has been examined of this most distinctive species. It seems rather out of place among the New Guinea species and to fall more with *O. poeticus* of South Western Australia and with *O. stellans* of Victoria. This relationship may be real, though remote. However, the form of the tegumen is different, so that in a classification based on form of genitalia alone it would fall into a quite separate group, not very close to any other.

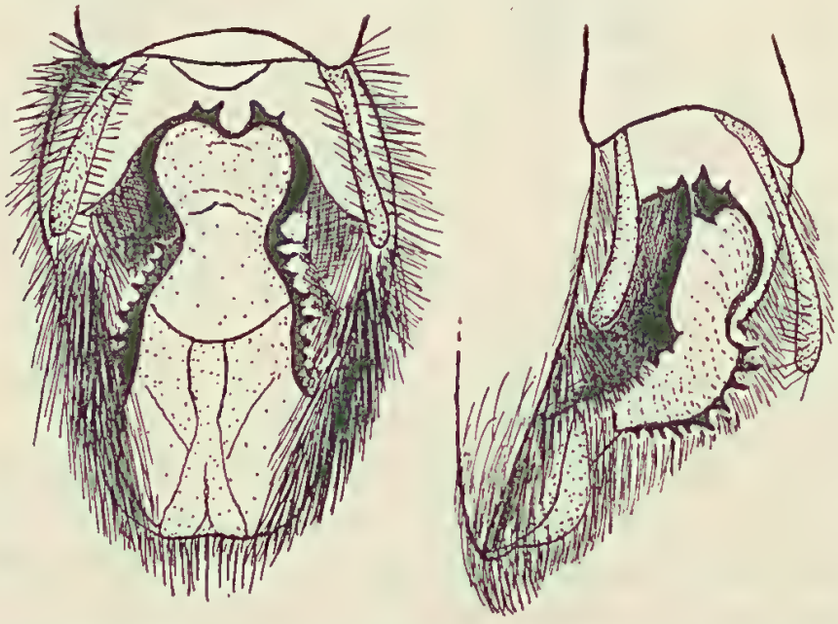


Fig. 2. *Oxycanus rileyi* Tindale, Nomnagihé, 25 miles south of Wangaar, male genitalia, ventral and oblique lateral views.

The male genitalia (fig. 2), so far as they may be seen in the type without dissection, have the eighth sternite with posterior margin evenly concave; there is a long and slender harpe, and the tegumen, viewed from the side, shows anteriorly a pair of forwardly directed spines; the anterior half of the margin is unarmed and the posterior half well armed with about ten seriate spines. I have pleasure in associating with this species the name of Mr. N. D. Riley, to whom I am much indebted for opportunities to study material from the British Museum.

OXYCANUS POSTFLAVIDA (Rothschild)

Plate xxix, fig. 5 and text fig. 3

Porina postflavida Rothschild, 1915, *Lepidoptera of British Ornith. Union Exped. to New Guinea*, p. 145.

"Male. Antennae brown; head and thorax blackish-chocolate; abdomen buff. Forewing blackish-chocolate with four transverse rows of dull orange

fulvous rings. Hindwing semihyaline buff, nervures and margins broadly orange." Forewing length 25 mm., expanse 55 mm.

Loc. New Guinea: Carstensz Peak, 5,000-10,000 feet, February to March, 1913, A. F. R. Wollaston. Type, unique, in British Museum (ex Tring).

The antennae in this species are relatively long, nearly one-fourth the length of forewing and each segment is surrounded by a complete ring of hairs; the palpi are very short and concealed in the dense hairy clothing of face.

The genitalia, so far as they could be observed in the type, are shown in free-hand sketches (fig. 3). The posterior margin of the 8th sternite is convex and the tegumen, viewed from the side, is seen to be arched and well armed, with

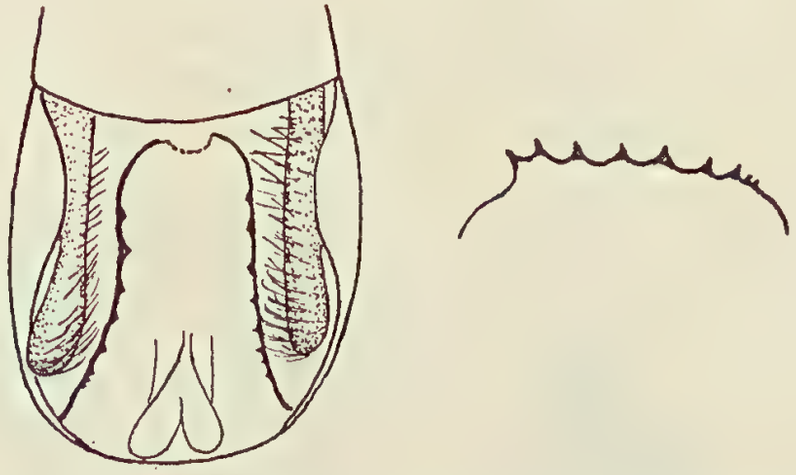


Fig. 3. *Oxycanus postflavida* (Rothschild), Carstensz Peak; freehand sketches of male genitalia of type; left, ventral view; right, silhouette of right tegumen as viewed from right side.

seven large spines, followed by two small ones. In the general form of the genitalia this species is nearest to *O. tamsi* from Mt. Goliath, this also is a species from a moderately high altitude, emerging at about the same time of the year. However, the shape and markings of the wings, as well as details of the genitalia are quite different, it being noted that the spines of *O. postflavida* are more acutely pointed and rather more evenly dispersed along the margin of the tegumen, the right and left sides of which appear more widely separated.

OXYCANUS TAMSI sp. nov.

Plate xxvii, fig. 1-3 and text fig. 4

Male. Antennae dark ochreous, short, stout, tapered. Head and thorax pale brown, abdomen ochreous, slightly darker at apex. Forewing bright ochreous with a dusting of fine black and brown scales; costa, a band from near costa at $\frac{3}{4}$ to inner margin at $\frac{2}{3}$, and blotches surrounding small black spots near

termen grayish-brown, and showing a faint violaceous bloom; at the costa itself the transverse band is grayish-white; there is a black blotch in the discoidal area and a series of black margined silvery-white discoidal spots, also some additional subterminal marks just beyond the grayish transverse band. Hindwings bright ochreous, the dense hair near base appears slightly darker. Wings beneath rather uniformly ochreous, without markings. Forewing length 38 mm., expanse 83 mm.

Loc. New Guinea: Mt. Goliath, 5,000-7,000 feet, February, 1911 (A. S. Meek); type, a male in British Museum (ex Tring); also fourteen paratypes taken in January and February.

Like many of its congeners this species is variable in colour and markings. The type example (plate xxvii, fig. 1) is representative of a bright ochreous, silver-spotted phase; a further example (plate xxvii, fig. 3), also taken in

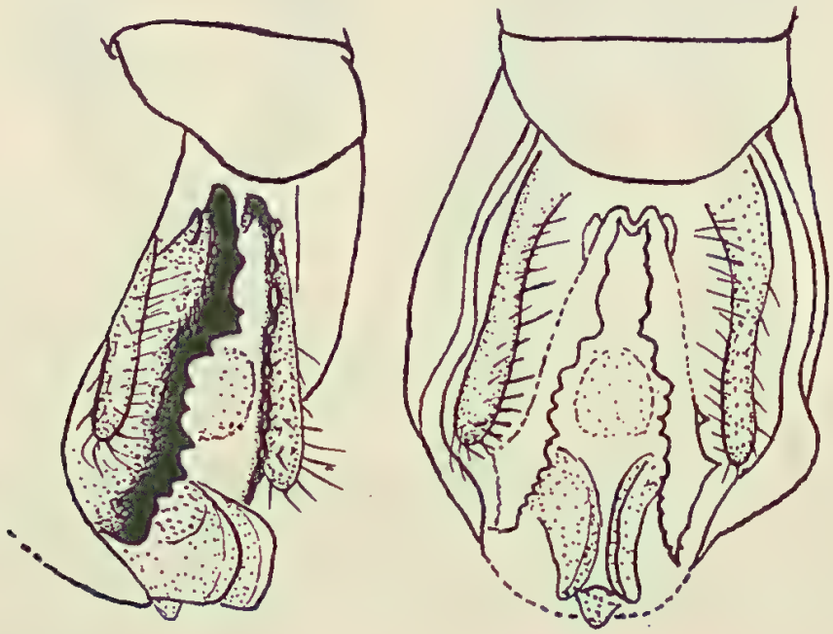


Fig. 4. *Oxycanus tamsi* Tindale, Mt. Goliath, January, genitalia of paratype male, oblique lateral and ventral views.

February, represents a darker form with the silvery-white spots remaining only as dark marks and the slightly violaceous grayish-brown bands somewhat extended. A third example (plate xxvii, fig. 2), taken in January, is an intermediate form. In the almost pointed forewings this species stands a little apart from the other New Guinea species, and at first sight it bears a superficial resemblance to some examples of the genus *Phassodes*, from Fiji. Of Australian species it might bear some relationship to *O. beltistus* and its allies, which share a somewhat similar type of genital armature, but the rather peculiarly shaped

hindwings, which are characteristic of several other New Guinea species, may suggest that the relationship with Australian forms is no closer than with several other New Guinea species.

The male genitalia have the 8th sternite with hind margin strongly convex; the harpes are relatively long and slender; the tegumen, viewed obliquely, is strongly and bluntly serrated, with the silhouette not markedly irregular save for the slight elevation of the spines immediately before the middle, followed by a series of slightly depressed ones (fig. 4).

The name chosen for this interesting species is that of Mr. W. H. T. Tams, to whom I am indebted for much hidden help in checking details on specimens in the British Museum.

OXYCANUS XOIS sp. nov.

Plate xxix, fig. 1-2 and text fig. 5

Male. Antennae dark ochreous, short, relatively thick-set; head and thorax dull brown, abdomen ochreous fawn, apex a little more ochreous. Forewings brown with ochreous-brown patches surrounding black spots some of which show traces of an ochreous centre; a more or less connected series of black marks from

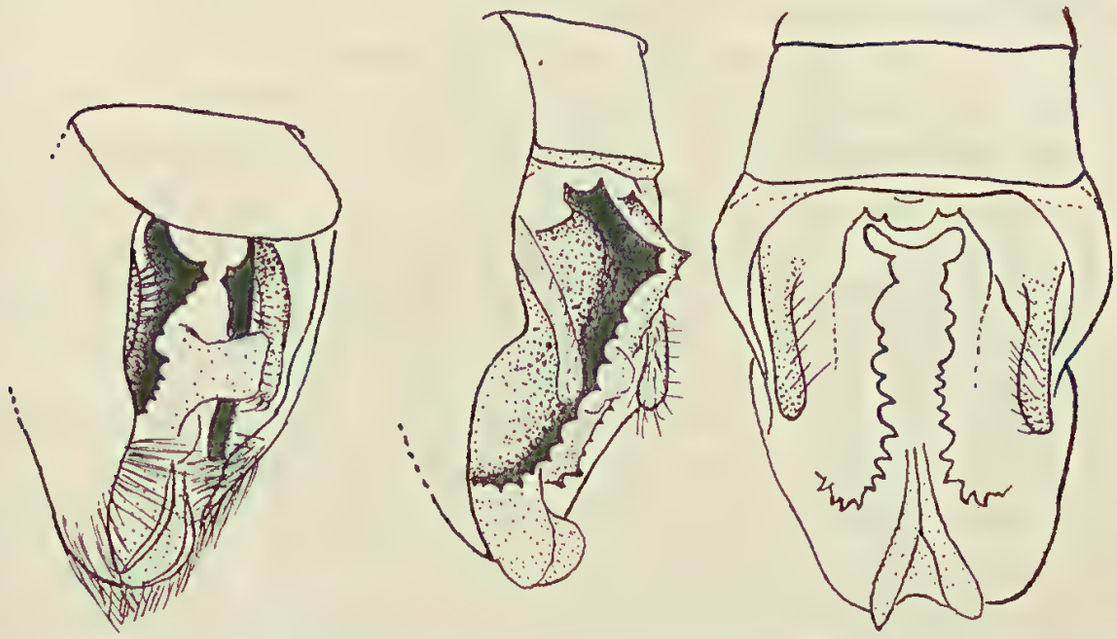


Fig. 5-6. Fig. 5 (left). *Oxycanus xois* Tindale, Dohunschik, Arfak Mts., male genitalia, oblique view. Fig. 6 (right). *Oxycanus dives* Tindale, Mt. Kunupi, male genitalia, oblique lateral and ventral views.

near costa at two-thirds obliquely to disc, thence to inner margin at one-half. Hindwings ochreous fawn, the down at base of wing appears lighter, termen narrowly, and veins ochreous. Wings below ochreous fawn with the markings above repeated as traces. Forewing length 23 mm., expanse 50 mm.

Loc. New Guinea: Dohunsehik, Arfak Mountains, 1,400 metres, June, 1928, Dr. E. Mayr; type, a male in British Museum (ex Tring); a second specimen is from Angi Lakes, Arfak, 1,800 metres, June, 1928, Dr. E. Mayr.

This is one of the smaller species of New Guinea *Oxycanus*; it is not very close to any other.

The genitalia of the male present rounded posterior margin to the 8th sternite, a strongly spined tegumen, elevated with a pair of spines in the anterior third and a median excavated area (fig. 5).

In the well-rounded shape of the wings this species falls close to *O. fuliginosa,* but the apex of the forewings is not as rounded and the armature of the tegumen places it far closer to *O. tamsi* from Mt. Goliath; from that species it differs markedly in the abundantly spotted forewings, as well as in details of the genitalia.

OXYCANUS DIVES sp. nov.

Plate xxviii, fig. 1-4 and text fig. 6

Male. Antennae ochreous, well developed; head and eyes large, dark brown, thorax and abdomen somewhat paler, base of abdomen slightly ochreous. Forewings with costa and inner margin pale grayish-brown, rest of wing generally chocolate-brown with ochreous scales near costa towards apex, near inner angle, and partly margining otherwise black outlined silvery-white spots in discal area. Hindwings dull ochreous, brighter towards termen. Wing below obscurely ochreous. Forewing length 37 mm., expanse 81 mm.

Loc. New Guinea: Mt. Kunupi, Menoo Valley, Weyland Mts., 6,000 feet, November to December, 1920 (C., F. and J. Pratt), type in British Museum; also thirty paratypes with same details and one marked, December, 1920, to January, 1921.

This species presents a wide range of variation. Of the colour phases a dark form has been described and figured as typical (plate xxviii, fig. 1). Among notable variants there is an ochreous-brown-spotted form (plate xxviii, fig. 2) and a dark form with a median longitudinal white flash on forewing (plate xxviii, fig. 3). In addition there is an ochreous form with markings largely suppressed except for a diffuse brown transverse bar from costa at $\frac{4}{5}$ths to inner margin at $\frac{2}{3}$rds, and a few dark brown spots (plate xxviii, fig. 4). Intermediates occur between these forms.

The genitalia show a markedly serrated tegumen, a little produced towards the anterior end (fig. 6). As usual in species with a serrated tegumen there are slight variations in the development of individual spines; the degree of

asymmetry evident in the figured example is of the usual order. The genitalia suggest a relationship between this species, *O. serratus*, from Wondiwoi, and *O. subochracea*, but the resemblances do not extend to the wing-form, patterns, or size, which are very different.

If the same brief emergence limits hold for Papuan species as for Australian ones, this should be mainly a December species. The Messrs. Pratt took a long series, all males, of which ten examples have been examined in detail at Adelaide —the others during a visit to the British Museum.

OXYCANUS SUBOCHRACEA (Joicey and Talbot)

Plate xxvi, fig. 2-3 and text fig. 7

Porina subochracea Joicey and Talbot, 1917, *Ann. Mag. Nat. Hist.* (8), 20, p. 85, plate 2, fig. 12.

Porina argentipuncta Joicey and Talbot, 1917, *lc.* p. 85, plate 2, fig. 13.

Paraoxycanus subochrea Vietta, 1950, Zool. Med., Leiden, 31, p. 71, fig. 6.

Male. Antennae short, tapering, pale ochreous, head and thorax brownish-ochreous, abdomen paler. Forewing brownish-ochreous with some gray along costa; a series of silvery-white spots, narrowly margined with dark brown, larger in discal area, where the largest is partly surrounded by an ochreous-brown suffusion darker along veins and towards inner margin at one-half; a wide

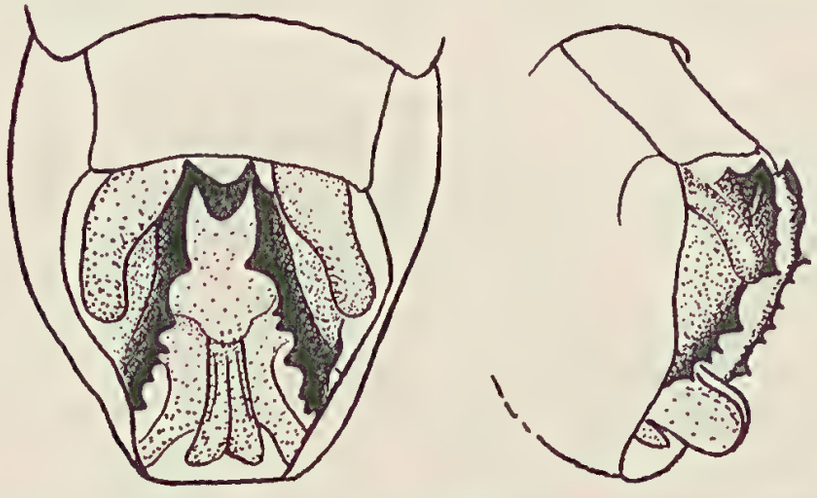


Fig. 7. *Oxycanus subochracea* (Joicey and Talbot), Wandammen Mts., November, male genitalia, ventral and oblique lateral views.

suffused grayish-white band from costa at ¾ths to inner margin at one-half, within it a line of small spots; between band and termen a series of spots, some large; a subterminal series of small spots surrounded by whitish-gray, one between each pair of veins. Hindwings subhyaline, pinkish-ochreous without markings. Forewing length 27 mm., expanse 60 mm.

Loc. New Guinea: Wandammen Mountains, 3,000-4,000 feet, November; type, a male, also type of *argentipuncta,* same details, and a series of paratypes from the type locality in British Museum; two males (ex Tring) in South Australian Museum.

The two named forms associated here are undoubtedly conspecific. The above description is based on an example which is almost identical with the type of *O. argentipuncta.* The genitalia have the outline of the tegumen, as viewed obliquely, rather evenly arcuate with only 6 to 7 small seriate spines which, in ventral view, appear to be irregularly placed (fig. 7). The differences in wing markings, between the two named forms, though considerable, follow the usual trend of variation; the typical one has a longitudinal white flash on forewing; the *argentipuncta* form has the flash absent, the spots are enlarged and these have conspicuous silvery-white centres. Plate xxvi, fig. 3, shows a third form in which the forewings are paler, the spots are black, and each is surrounded by an area of ochreous suffusion. In still other examples most of the markings are suppressed in favour of a uniform ochreous suffusion with scatterings of individually darker scales.

OXYCANUS HECABE sp. nov.

Plate xxviii, fig. 5 and text fig. 8

Male. Antennae ochreous, relatively long, pectinations 1. Head and thorax pale brown, abdomen palest salmon, becoming grayish-fawn towards apex. Forewings brown with bright ochreous suffusions towards base and paler ochreous along termen from near apex to beyond middle; several silvery-white marks bordered with brownish-black; traces of a slightly paler brown band from costa at two-thirds to inner margin at two-thirds partly margined by a series of ochreous patches, some embracing small spots; costa grayish-brown; a series of white-centred subterminal spots. Hindwings ochreous, becoming salmon-tinged towards base. Costa of forewings below narrowly brownish-black, rest of wings ochreous. Wing length 32 mm., expanse 70 mm.

Loc. New Guinea: Hunsteinspitze, 1,350 metres. Kaiserin Augusta Fl. Expedition, February to March, 1913, S. G. Bürgers (Sepik River). Type, a male, No. 4,509 in Berlin Museum; a paratype, same details, in South Australian Museum.

OXYCANUS HECABE form lethe nov.

Plate xxviii, fig. 6 and text fig. 9

Male. Antennae ochreous, appearing slightly shorter than in typical *hecabe.* Head and thorax ochreous gray, abdomen pale salmon, apical half becoming

grayish-fawn. Forewings grayish-ochreous with two moderate black spots and four subhyaline gray bands across wing; each band encloses a series of small black spots; the band commencing at 5/6th costa, runs only to near termen at about M_2 vein; it is ochreous-tinged near costa; the fourth band is obscure, subterminal, and encloses a series of subterminal black spots each ringed with gray; cilia dark gray. Hindwings ochreous with a fuscous suffusion near posterior angle. Wings below ochreous, without markings; costal margin scarcely darker than rest of wing. Forewing length 29 mm., expanse 64 mm.

Loc. New Guinea: Hunsteinspitze, 1,350 metres, August, 1912, S. G. Bürgers. Type, a male, in Berlin Museum, a paratype male, same details, but labelled February-March, 1913, in South Australian Museum.

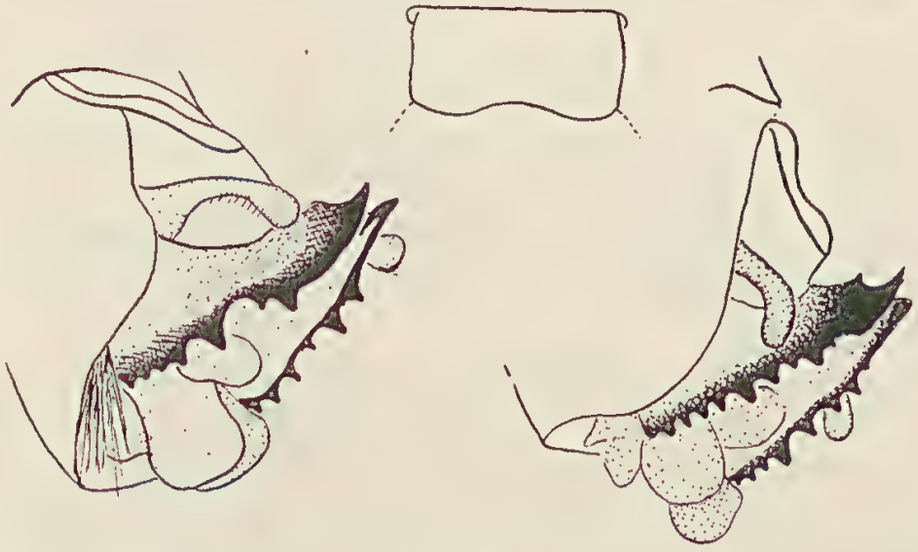


Fig. 8-9. Fig. 8 (left). *Oxycanus hecabe* Tindale, Hunsteinspitze, February to March, male genitalia, oblique lateral view. Fig. 9 (right). *O. hecabe* form *lethe* Tindale, Hunsteinspitze, August, eighth sternite and male genitalia, oblique lateral view.

The four specimens of *O. hecabe* available for study were taken at two different periods of the year, nearly six months apart. They belong to two very different colour forms which differ also in size and might almost be considered to be separate species. However, these colour changes cut across some slight structural differences in the genitalia, as may be seen from the following table:

	hecabe type	*hecabe* paratype	f. *lethe* type	f. *lethe* paratype
Colour	brown	brown	ochreous gray	ochreous gray
Wing length	32 mm.	28 mm.	29 mm.	29 mm.
Tegumen	irregularly serrated	irregularly serrated	regularly serrated	irregularly serrated
Emergence period	Feb.-March	Feb.-March	August	Feb.-March

Bearing in mind the inherent variabilities of colour pattern, repeated in so many species of *Oxycanus*, it might seem that there are two races or forms

of *O. hecabe,* genetically isolated since they emerge at different times of the year. These, perhaps, are descended from a common stock which already possessed two colour phases. Though now structurally differentiated and possessing different-seeming genitalia, the *lethe* colour phase still tends to appear in each strain. When further material is collected it will be of interest to learn whether a *hecabe*-like form appears also in the August appearing strain.

According to another possible explanation, *O. hecabe* and *O. lethe* could be two separate species of which one, *O. hecabe,* is variable and presents two separate forms, one of which is less readily differentiated from *O. lethe* on a basis of wing patterns. Both the above are attempted explanations of the presence of these two forms; they furnish another of the many significant problems associated with the study of these interesting species.

O. hecabe is probably closest to *O. subochracea* and in the key these species fall near to each other. One of the forms of *O. subochracea,* figured at plate xxvi, fig. 3, shows many points of resemblance to the form *lethe* of this species. However, the two species are separable on several characters of which one of the more evident is wing shape; the forewings of *O. subochracea* are relatively broader and the apex of hindwings somewhat less acute. The harpes also are of quite different shape.

The genitalia of *O. hecabe* (fig. 8) have the posterior margin of the eighth sternite transverse and slightly notched; the tegumen is armed with seriate spines which are somewhat irregularly disposed and irregular in size. In the form *lethe* (fig. 9) the seriate spines of tegumen are rather more even in size and arrangement.

OXYCANUS SERRATUS sp. nov.

Plate xxvi, fig. 6 and text fig. 10

Male. Antennae short, slender, tapering, pale ochreous; head pale brown, thorax paler, abdomen pale fawn with a pinkish tinge on basal half. Forewings pale brown, costa slightly more grayish-brown; two series of silvery-white spots each margined with brown; one a discal series of scattered spots, several of them partly embracing an irregular discal black patch; the other a transverse series running in stepped fashion in a line from near apex to near posterior angle; on the inner side of this line is a pale gray transverse band in which there are small brown spots; a subterminal series of small spots also are surrounded by pale grayish-white. Hindwings opaque yellowish-ochreous with the cilia rather evenly dark gray; wings below yellowish-ochreous. Forewing length 28 mm., expanse 60 mm.

Loc. New Guinea: Wondiwoi, Wandammen Mountains, 1,400 metres, July, 1928, Dr. E. Mayr. Type, a male, in British Museum (ex Tring). There is a paratype example.

This form is so similar in markings to some examples of *O. subochracea,* taken in the same mountains, that it is difficult to separate it until the genitalia are examined. There is between a three and a five months difference in emergence date. The Wondiwoi examples of *O. serratus* were taken in July at an elevation of just over 4,500 feet, whereas *O. subochracea* flies in November at 3,000-4,000 feet.

The type of *O. serratus* (plate xxvi, fig. 6) compares well with the *O. argentipuncta* form of *O. subochracea,* and it was thought at first that the name *argentipuncta* might be used for it. However, the type of *argentipuncta* was taken in November and unquestionably is an *O. subochracea* form.

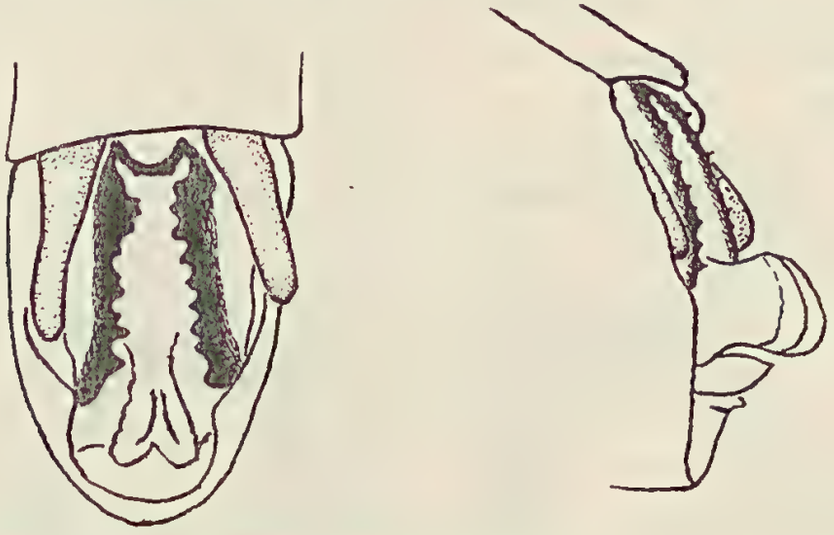


Fig. 10. *Oxycanus serratus* Tindale, Wondiwoi, July, male genitalia, ventral and oblique lateral views.

The second example of *O. serratus* is an ochreous variant in which the brown of the thorax and wings and the pale transverse band of forewing are replaced by a bright ochreous colour; the silvery-white spots remain but tend to be slightly smaller, with the dusky margins sometimes encroaching on the white centres. This example was formerly identified as an example of *O. argentipuncta,* which it rather closely resembles, but like the type example, its genitalia are of *O. serratus* pattern. The essential difference lies in the contrast between the rather regularly serrated margin of the tegumen (fig. 10); as viewed from below, and the very irregularly serrated margin found in *O. subochracea.* The former has 9-10, the latter 6-7 spines. Another not so evident difference exists in the shape of the forewings, which are relatively narrow in *O. serratus* and

shorter and broader in *O. subochracea*. Despite the similarities it seems proper to regard them as separate species. If the two belong together then the genitalia must be very variable and the emergence period in this species must be an extended one, unlike other members of this puzzling genus.

OXYCANUS THASUS sp. nov.

Plate xxvi, fig. 5 and text fig. 11

Male. Antennae ochreous, short; head and thorax grayish-fuscous, abdomen pale ochreous-fuscous, duskier towards apex. Forewings with costa grayish-fuscous, elsewhere paler, with tinges of ochreous-fuscous; basal half of wing suffused whitish-ochreous with traces of a narrow median longitudinal light streak; several rows of small feebly white-centred fuscous dots across wing including a rather regularly spaced subterminal series. Hindwings pale ochreous-fuscous with terminal fourth from below apex to inner margin noticeably fuscous. Wings below pale ochreous. Forewing length 22 mm., expanse 50 mm.

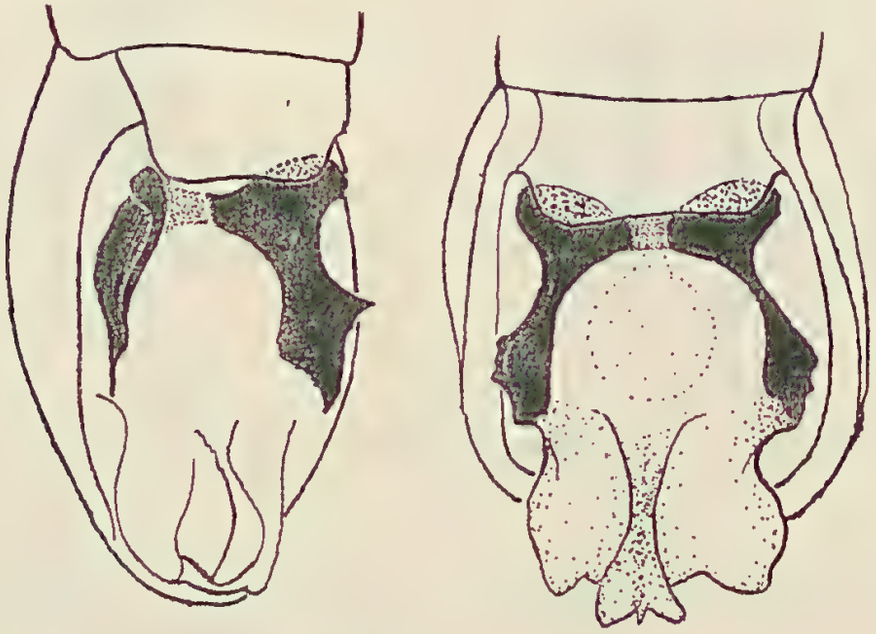


Fig. 11. *Oxycanus thasus* Tindale, Fak Fak, male genitalia, oblique lateral and ventral views, of type.

Loc. New Guinea: Fak Fak, 1,700 feet, December, 1906 (Pratt). Type, a male, 1911-117 in British Museum, unique.

The sub-rectangular hindwings are shared with several other Papuan forms such as *O. meeki*, from Biagi, and *O. perplexus*, from Ninay Valley. This species seems close in wing pattern to the non-fasciate form of *O. mayri* but in their genitalia these species bear little resemblance to each other.

The male genitalia (fig. 11) have the eighth sternite with a slightly excavate posterior margin; the harpes are concealed and anteriorly the tegumen is strongly chitinised; there is a large strap-like anterior projection behind which the tegumen is rather evenly excavate to the middle where it is again produced, showing from one angle a spine-like process, and from below a rather broad slightly dentate eminence.

In the only specimen parts of the genitalia are concealed by the eighth sternite, but the two camera-lucida sketches as shown, modified by free-hand sketching to suggest the approximate form of the hidden parts, should assist identification.

OXYCANUS SALMONACEA (Rothschild and Jordan)

Plate xxvi, fig. 7, plate xxix, fig. 7 and text fig. 12

Porina salmonacea Rothschild and Jordan, 1905, *Novit. Zool.*, 12, p. 478.

Male. Antennae pale buff, very short, stout and tapering rather abruptly to tip. Head and palpi mummy-brown, thorax slightly paler, abdomen loose-haired, buff with a salmon tinge. Forewings ochreous-buff with costa slightly darker. Four black-edged spots in discoidal region, usually conjoined in pairs; there are traces of other spots with light centres; terminal third of wing paler, with a subterminal darker band embracing vague traces of spots from costa near apex to inner margin. Hindwing pinkish-buff becoming slightly more rose-coloured near base. Length of forewing 25 mm., expanse 56 mm.

Loc. Papua: Angabunga River, affluent of St. Joseph River, 6,000 feet upwards, November, 1904, to February, 1905, A. S. Meek. Type, a male, in British Museum (ex Tring), and a series of paratypes; one example with same details in South Australian Museum (from Tring).

The large tuft of hairs at base of the antenna is notable. This species has a generally rough-haired look shared with *O. fuliginosa*, which also is a form from relatively high altitudes. However, the two species are entirely different in colour and markings. Plate xxix, fig. 7, shows the type in the British Museum (ex Tring) and plate xxvi, fig. 7, shows the South Australian Museum specimen.

The genitalia (fig. 12) which have an anterior eminence on the tegumen, followed by a notch and several spines, may suggest a relationship with *O. thoe* of the Wandammen coast. However, the species emerge at different times of the year, one not far from sea level and the other at 6,000 ft. elevation, and though superficially similar in markings, they differ in size, wing-shape, and details of the genitalia. In *O. salmonacea* the anterior spine of the tegumen, as viewed from below, is outwardly curled as a short flat strap-like spine with up to three

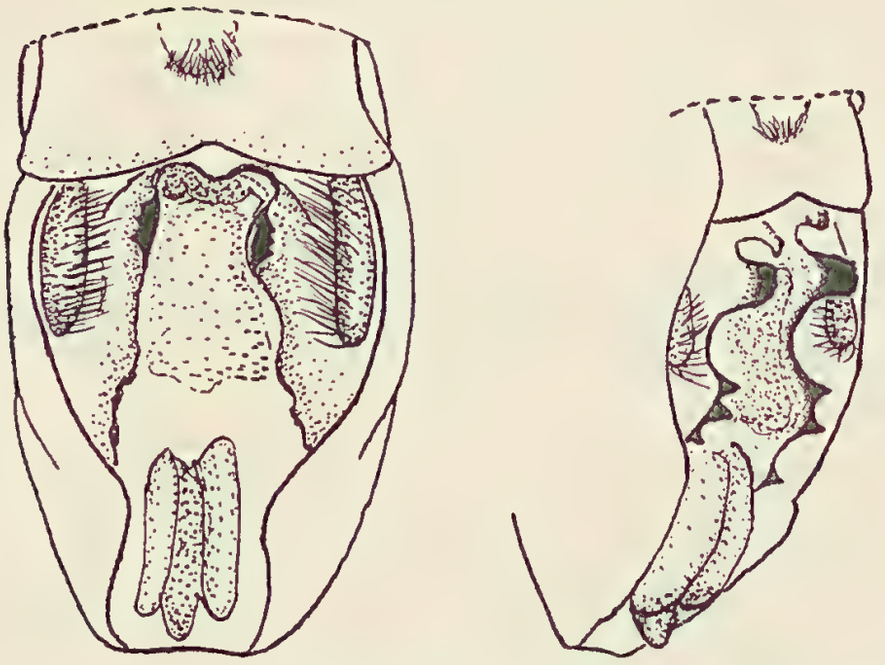


Fig. 12. *Oxycanus salmonacea* (Rothschild and Jordan), Angabunga River, male genitalia, ventral and oblique lateral views.

slight projections on it, whereas in *O. thoe* the spine tends to be a high, rather more rounded eminence, projecting outwards, usually as a single rounded point. The eighth sternite is different in the two species, having a notched posterior margin in *O. salmonacea* and an only slightly arched one in *O. thoe*.

There is a specimen in the British Museum labelled Mafalu (?=Mafulu), 6,000 feet, August, 1903 (A. E. Pratt), which seems close to this species. It was not possible to examine the genitalia. It will be noted that the season of emergence is entirely different (August instead of November-February), hence the possibility that it will prove, on further study, to be a separate species.

OXYCANUS NIGRIPUNCTA (Joicey and Talbot)

Text fig. 13

Porina nigripuncta Joicey and Talbot, 1917, *Ann. Mag. Nat. Hist.* (8), 20, p. 83, plate 2, fig. 10.

Porina nigricosta Joicey and Talbot, 1917, *lc.* p. 84, plate 2, fig. 11.

Male. Antennae pale ochreous; palpi, head and thorax above brownish-ochreous, thorax below and abdomen pale ochreous. Forewings ochreous gray numerous transverse brownish-black spots (sometimes with pale centres) between the veins, ones at middle and end of cell and near junction of M_4 and Cu_{1a} larger than the others; traces of a line of brown suffusion from costa at

three-fifths to inner margin at one-half; a similar faint suffusion from four-fifths costa to near inner angle. Hindwings ochreous; an indistinct series of subterminal spots between the veins. Wing length 36 mm., expanse 78 mm.

Loc. New Guinea: Wandammen Mountains, 3,000-4,000 feet, in November. Type, a male, also type of *O. nigricosta,* same details, in British Museum.

There seems to be little doubt that *O. nigripuncta* and *O. nigricosta* are merely colour forms of the one species.

O. nigricosta has the forewings with costa darker, the dark spots larger, and the spots, linked to form faint transverse streaks at three-fifths and four-fifths, are broadened into dark bands extending nearly to hind margin. Both forms are figured in colour by Joicey and Talbot. The structure of the genitalia, so

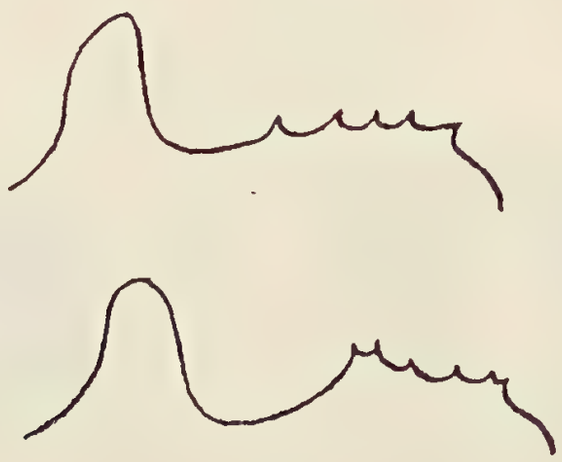


Fig. 13. *Oxycanus nigripuncta* (Joicey and Talbot), upper, silhouette of tegumen of *nigricosta,* type; lower, the same of *nigripuncta,* type (anterior extremity at left).

far as they can be seen in the types are the same, and the ranges of variation in other characters are only such as are commonly found within specific limits in other species of the genus.

The main outlines of the tegumen were sketched, free-hand, during an examination of the types in the British Museum (fig. 13). The upper figure is that of the type of *O. nigricosta,* the lower that of *O. nigripuncta.* The species falls into a suite in which *O. salmonacea* from Angabunga River at 6,000 feet, *O. thoe,* from Wassior at sea level, in July, and *O. meeki,* from Biagi at 5,000 feet, taken about March, are kindred forms. In *O. meeki* the main process of the tegumen is placed in a medial position much behind that found in the present form.

OXYCANUS THOE sp. nov.

Plate xxvi, fig. 4, plate xxx, fig. 3 and text fig. 14.

Male. Antennae ochreous, short, pectinations very short, palpi brownish-ochreous, head and thorax ochreous, abdomen pale ochreous. Forewings subfalcate, brownish-ochreous with a broad somewhat more grayish-brown band across forewing from costa at threequarters to near inner margin; a number of white-centred brown spots between the veins; two large silvery-white centred spots in disc and some smaller ones; traces of a dark brown streak from near base of wing to termen before one-half. Hindwings pale ochreous, tinged with pink in basal half, cilia nearly concolorous with rest of wing. Length of forewing 33 mm., expanse 72 mm.

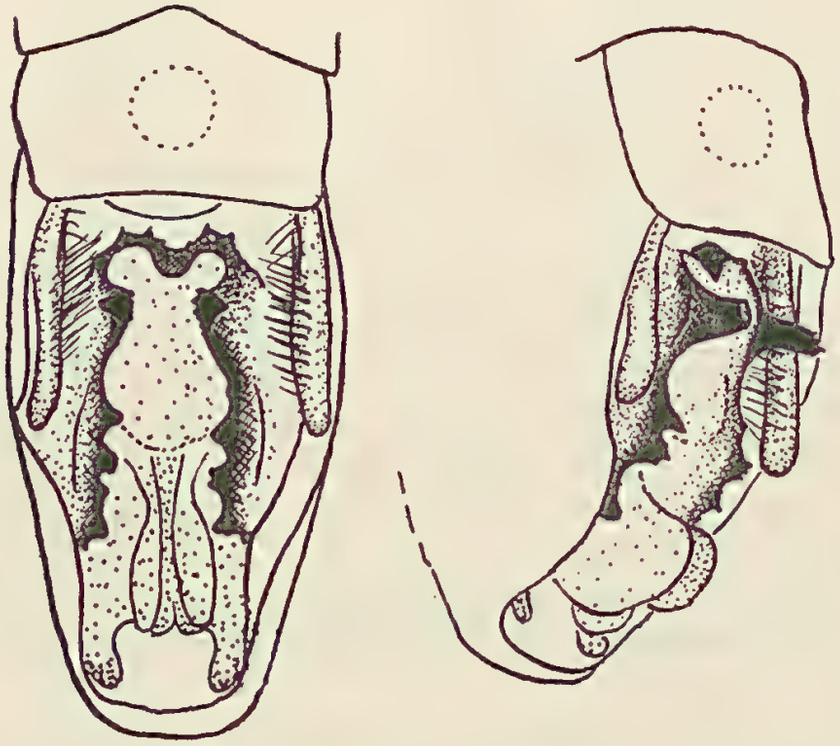


Fig. 14. *Oxycanus thoe* Tindale, Wassior, July, male genitalia, ventral and oblique lateral views.

Loc. New Guinea: Wassior, Wandammen coast, July, 1928, Dr. E. Mayr. Type, a male, in British Museum; there is a paratype with same details.

This is a relatively large species with rather broad forewings (plate xxvi, fig. 4), having a tendency to truncated hindwings, as seen also in the much smaller *O. salmonacea* from the Angabunga River. The genitalia of these two species fall into the same group, the arming of the tegumen being similar, except for details. The posterior margin of the 8th sternite is almost transverse

in this species, whereas it has a wide median notch in *O. salmonacea.* The tegumen (fig. 14) has an outwardly bent, blunted spine on the anterior third, slightly variable, as may be seen from the two drawings, one from the type and the other from the paratype. In this species the harpes are more slender than in *O. salmonacea.*

The second example (plate xxx, fig. 3) has the wing tips injured. It differs from the type in having a black streak from base of forewing to termen just above 1/2. This form has a close superficial resemblance to *O. salmonacea.*

OXYCANUS ALBOSTRIGATA (Rothschild)

Plate xxix, fig. 3, plate xxx, fig. 7-8 and text fig. 15

Phassodes albostrigata Rothschild, 1913, *Novit. Zool.,* 20, p. 278.

Male. Antennae ochreous, short, slender, pectinations 1. Head and thorax grayish-fuscous, abdomen gray. Forewing with costa narrowly gray, rest of wing ochreous fuscous, paler towards apex of wings with darker fuscous suffusions; two series of irregularly connected silvery-white spots margined with fuscous in discoidal area; a single ochreous-centred spot near inner margin at one-half and other smaller ones forming a series along costa and scattered across wing. Hindwings with anterior half pale ochreous-fuscous, posterior half darker; a series of small vaguely pale-centred gray spots, one between each vein along termen. Forewing length 30 mm., expanse 65 mm.

Female. Antennae ochreous, very short, slender and simple; head and thorax pale grayish-fuscous, abdomen pale fawn. Forewings pale ochreous-fuscous, with paler ochreous markings in patches between the veins; two groups of silvery-white discoidal markings as in male; other markings present are margined with ochreous; hindwings pale ochreous-fawn, without subterminal spots. Forewing length 38 mm., expanse 81 mm.

Loc. New Guinea: Bolauberg, Huon Gulf, 3,600 metres (Keysser). Type, a female, in British Museum (ex Tring); Rawlinson Mountains (Keysser), allotype, male, described herein; an additional series of five females has been examined.

Hitherto known only from the type, a female in the British Museum (ex Tring). This was taken on Bolauberg, inland from the Huon Gulf, at 3,600 metres. This example, expanding 72 mm., is somewhat similar in markings and colour to some males of *O. mayri* from Mt. Siwi, but is unlikely to be conspecific. Plate xxix, fig. 3, depicts the type. Structurally this species is notable for the relatively long 3rd segment of the palpi which are carried directed downwards and forwards.

The male is now described from takings in the same area; the second female example, also figured, was taken along with this male on the Rawlinson Mountains of which Bolauberg is a part. The wing markings of the two sexes are similar although the small terminal gray spots on the hindwing are absent from the female; the suffusions on forewings of the female are ochreous rather than grayish-brown, and there is less infuscation in the discoidal area. Two of five females examined are larger and have the forewings rather gray in colour.

As indicating our relative paucity of material in this genus from New Guinea, this is the only New Guinea species of *Oxycanus* of which the female is yet known.

The male genitalia have the posterior margin of the eighth sternite slightly concave. The tegumen, in oblique lateral view, shows a slightly anteriorly directed, outwardly rolled projection, rather flat at summit, placed well before middle; also a slightly elevated median and posterior portion armed with two larger and several smaller spines. Fig. 15 shows as much of the genitalia of the allotype male as may be sketched without dissection; for convenience of presentation a view from the left side has been mirror-imaged to make it more directly comparable with drawings of other species, shown as viewed from the right.

The genitalia alone might suggest that this species falls near to *O. nigripuncta* and to *O. thoe* from Wassior; from both of these it is distinct in the form and markings of the wings. In the presence of small terminal spots on the hindwings there are suggestions of affinities with *O. eos* from the Cyclops Mountains, and *O. thasus* from Fak Fak; in the latter species these spots are only faintly represented.

OXYCANUS ATROX sp. nov.

Plate xxx, fig. 5-6 and text fig. 16

Male. Antennae ochreous, short, pectinations 1, delicate. Head and thorax ochreous-brown, abdomen pale fawn, more ochreous at tip and hairs pink-tinged at base. Forewings rich ochreous-brown, slightly darker towards termen with series of small brown markings, generally with ochreous centres and surrounded by ochreous suffusions. Hindwings ochreous-fawn, with hairs at base tinged pink; cilia fuscous. Wings below ochreous-fawn, cilia fuscous. Forewing length 33 mm., expanse 72 mm.

Loc. New Guinea: Buntibasa district, Kratke Mountains, 4,000-5,000 feet, August, 1932, F. Shaw Mayer. Type, a male, also two paratypes, taken July

and August, 1932, in British Museum (ex Tring); another paratype male, same details, was taken June, 1932.

The examples examined were taken during the three months June, July and August; the June example is superficially rather distinct; however, the genitalia are very close, differing only in minor details of the anterior spines of tegumen, which are slightly less conspicuous. An *Oxycanus* similar in appearance, taken

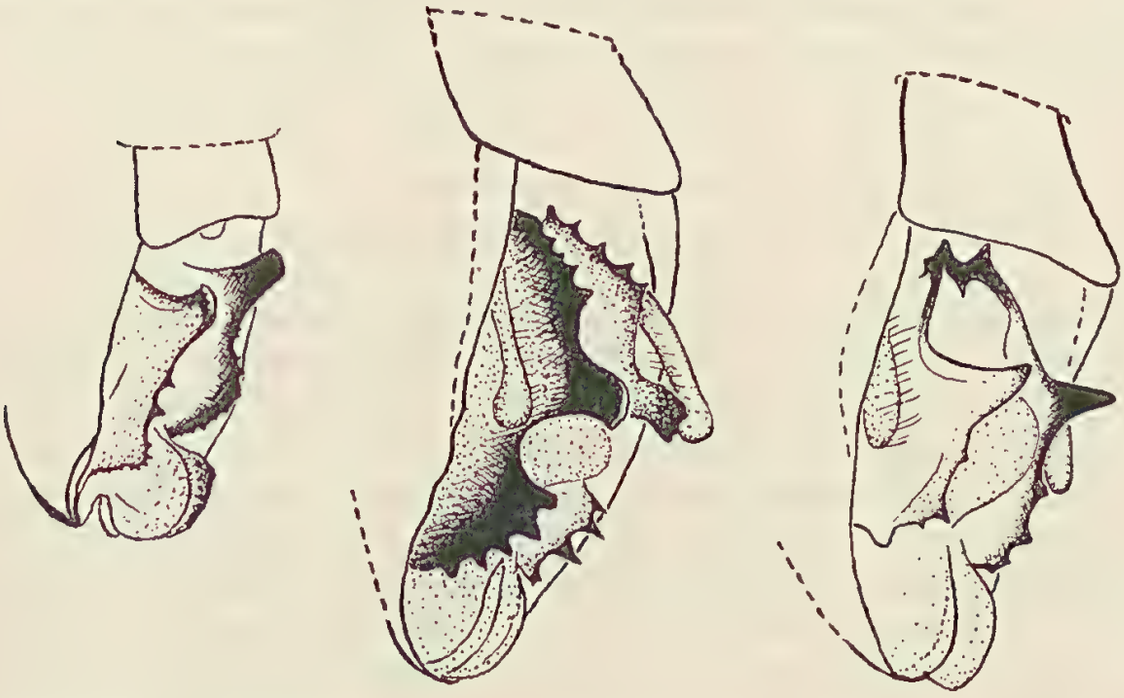


Fig. 15-17. Fig. 15 (left). *Oxycanus albostrigata* (Rothschild), Rawlinson Range, allotype male, genitalia, oblique lateral view. Fig. 16 (middle). *Oxycanus atrox* Tindale, Buntibasa, August, male genitalia, oblique lateral view. Fig. 17 (right). *Oxycanus eos* Tindale, Cyclops Mts., male genitalia, oblique lateral view.

in February, 1933, at the same place, may be a distinct species, but it has not yet been studied. It is in the British Museum (ex Tring). Evidently, as in other members of this genus, the species is variable in colour and markings; the type example represents an ochreous form with dark markings reduced and tending to be ochreous-centred, whereas one paratype (plate xxx, fig. 6) tends a little towards a florid form with more conspicuous dark markings and with white suffusions instead of ochreous ones. In the examples seen the strongly rounded hindwings are the same as is also the dark ciliation, which gives a rather clear-cut margin to the hindwing outlines; the dense clothing of down at the base of the hindwings is locally and strongly pink-tinged. In life the pink colour was probably most brilliant, but as in Australian species such as *O. stellans*, is fugitive, fading rapidly after death.

In the male genitalia (fig. 16), the tegumen is divided into an armed anterior portion with five or more spines, a median eminence, which has its body bent inwards towards the centre line but at the tip is bent outwards again, and a heavily armed posterior portion with five spines. The harpes are more slender and more conspicuously dilated at the apex than in the other species examined from New Guinea. The genitalia in general are quite unlike those of any other species, showing perhaps some distant relationship with those of *O. hebe* from Fak Fak. In the present species the enlargement of the central portion of the tegumen and its incurvature has not reached the extreme met with in *O. hebe*; instead the anterior and posterior armatures are emphasised.

OXYCANUS EOS sp. nov.

Plate xxix, fig. 4 and text fig. 17

Male. Antennae ochreous brown, very short, pectinations transversely carinate; head and thorax ochreous brown, abdomen somewhat paler. Forewings bright ochreous with costa and various suffusions brownish-ochreous—towards base colour is very rich; several series of transverse lines of small, generally pale-centred blackish-brown spots, a particular series, running from costa at three-fourths to hind margin at two-thirds, are obscurely margined in light grayish-fawn scales, the ochreous suffusions near base are richly coloured and there is a particularly evident patch of darker suffusion surrounding a relatively large black spot near posterior margin at one-half; cilia brown. Hindwings grayish-fawn, darker near anal margin, along termen ochreous with a series of faint brown spots between the veins. Forewing length 30 mm, expanse 64 mm.

Loc. New Guinea: Cyclops Mountains, August to September, 1928, Dr. E. Mayr. Type, a male, in British Museum (ex Tring); there is a paratype male with the same details.

This species is conspicuous for its pointed and relatively narrow forewings. Both examples examined are similar in markings, the paratype example differing chiefly in the absence of the pale band across forewing; the hindwing is less evidently infuscated.

In the genitalia (fig. 17) the outline of the tegumen is excavated at the anterior end and bears a large simple spine just before the middle; the posterior half shows several smaller spines; these are spaced rather widely apart.

This species is not close to any other; in the form of the armature of tegumen it falls nearest to *O. occidentalis* of South Western Australia, but in form of wings and coloration does not show close relationship with that species; its closest links possibly are with *O. albostrigata* from the Rawlinson Ranges, inland

from the Huon Gulf, and it shares with the male of that species, and with *O. thasus* from Fak Fak, the presence on the hindwing above of an inconspicuous series of terminal gray spots between the veins; in both these species, however, the genital armatures are different.

OXYCANUS PERPLEXUS

Plate xxxi, fig. 3-4 and text fig. 18

Male. Antennae ochreous, short, pectinations about 1. Head and thorax grayish-brown, tending more to gray on metanotum; abdomen pale creamy-fawn slightly darker at apex. Forewings pale grayish-brown, darkest along costa, with about eight rows of transverse creamy-white spots, outlined with brown; a median silvery-white flash runs from base to termen above one-half, where it turns towards apex; this fascia is wide near base then suddenly narrowed at one-half; a darker suffusion lies between it and margin; there is a subterminal series of spots, one between each vein. A faintly visible broad gray band runs from costa at four-fifths to just beyond inner angle. Hindwings creamy-fawn with subanal fourth of wing, extending to near apex, infuscated with grayish-brown; cilia grayish-brown. Wing length 27 mm., expanse 58 mm.

Loc. New Guinea: Ninay Valley, Central Arfak Mountains, 3,500 feet, November, 1908, to January, 1909. Type in British Museum; there are three paratypes with the same details.

The paratypes (for example, plate xxxi, fig. 3) appear rather different from the type because the broad gray transverse band from four-fifths costa to inner angle of forewing is emphasised and the silvery-white longitudinal flash tends to be suppressed. The cream-centred spots are the same as in the type (plate xxxi, fig. 4); the colour of the hindwings is identical.

The genitalia (fig. 18) have the posterior margin of the eighth sternite slightly convex. The tegumen has a smooth-margined anterior portion, rising at about a right angle into a large, median, outwardly twisted eminence, showing a slightly serrated outline and outwardly curved tip; behind this the margin drops to a shallow notch, followed by two or three rather evident, and several less conspicuous spines. The harpes are long, their tips extending to the first of the posterior suite of spines of tegumen. In postero-ventral view the central elevations of the tegumen appear as a pair of shining castaneous subquadrate plates, bent obliquely forwards.

This species and the two following are closely related, standing somewhat apart from other New Guinea species. They may be distantly related to the Australian *O. nuptialis* from Mt. Kosciusko. However, in that species the hind-

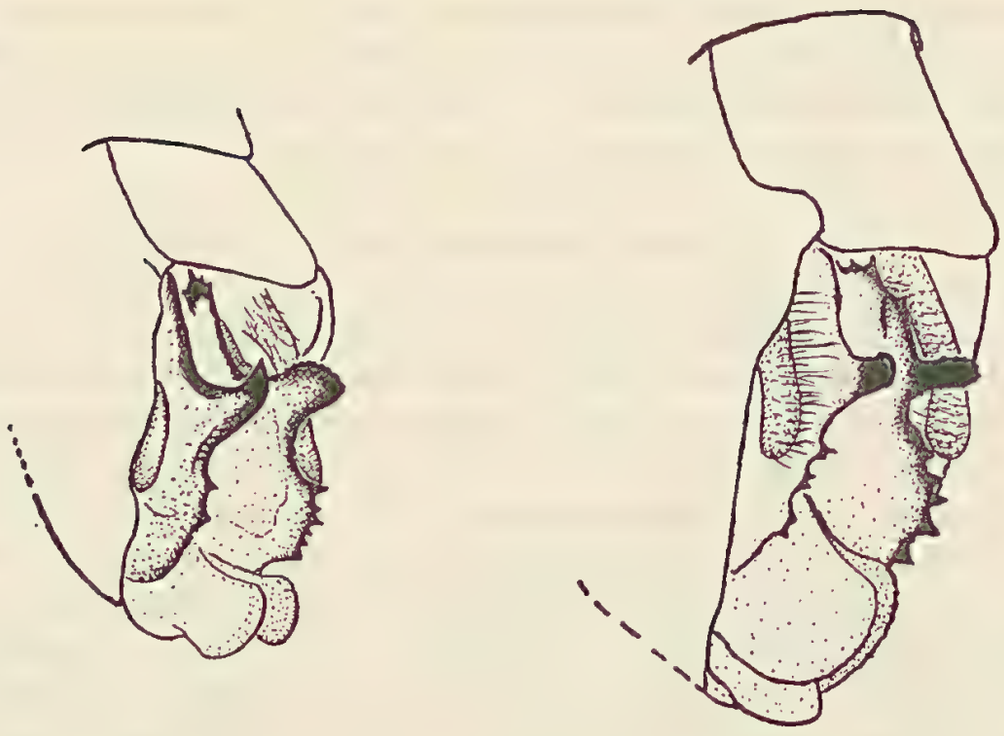


Fig. 18-19. Fig. 18 (left). *Oxycanus perplexus* Tindale, Ninay Valley, male genitalia, oblique lateral view. Fig. 19 (right). *Oxycanus meeki* (Viette), Biagi.

wings are more acute, the wings are subhyaline, and the genitalia show little relationship. There are resemblances to *O. subvarius*, also from Australia, particularly in the pattern of spots on the wings and the wing texture, but again the genitalia are very different. The mutual relationships of this and the two following species are discussed under the heading of the species *O. discipennis*.

OXYCANUS MEEKI (Viette)

Plate xxx, fig. 1-2 and text fig. 19

Paraoxycanus meeki Viette, 1950, Zool. Med., Leiden, 31, p. 69, fig. 5.

Male. Antennae ochreous, short, pectinations 1. Head, thorax and tip of abdomen brownish-ochreous, base of abdomen light pinkish-fawn becoming tinged with gray towards extremity; clothing of body and of hindwings relatively thick, scaling of forewings rather rough and hairy. Forewings pointed at apex, almost falcate in form, brownish-ochreous, darker along costa with some black- and some silvery-white-centred black spots, a creamy-white longitudinal flash from base to near termen above middle where it expands into a subterminal suffusion which runs from just below apex to end obscurely near anal angle; two conjoined lines of predominantly black spots cross the wing, the first from

near costa at five-sixths running nearly parallel to termen to touch anal angle; in the centre of the wing there is an obscure infuscation below the longitudinal white flash, basally from this the flash is much broadened; cilia brownish-ochreous. Hindwings angulate, costa and termen meeting nearly at right angles, pale pinkish-fawn, darker along costa and near anal angle; traces of spots, some obscurely white-centred, one between each vein of termen; cilia fawn. In life the down at base of wings was probably strongly pink-tinged, traces remain. Wing length 29 mm., expanse 62 mm.

Loc. New Guinea: Biagi, Mambare River, 5,000 feet, March, 1906, type in Paris Museum; a series of fourteen labelled January to April, 1906, A. S. Meek, from same locality are in the British Museum (ex Tring), and one, labelled March, 1906, in South Australian Museum.

As in other species of this genus, the wing markings show variations. The figured specimen (plate xxx, fig. 2) and one of the other examples seen are rather similar, although in the last named the silvery-white spots are a little larger. They share a longitudinal white flash extending from base of forewing nearly to termen where it expands into a broad fan-shaped suffusion from just below apex nearly to anal angle. In yet another example (plate xxx, fig. 1) the white flash is replaced by a similar, but brownish-black one. This type of variation, by colour replacement, is common in *Oxycanus* species.

The genitalia (fig. 19) have the 8th sternite with posterior margin straight. The tegumen has a slender, almost parallel-sided median spine with gently serrated outline, the tip of it is outwardly bent over. There is a single small spine in the middle of the anterior half of teguminal margin, and a set of five to six medium-sized spines on posterior half. On one margin of the example drawn these spines tended to be grouped together in pairs, this is not quite so evident on the other margin.

The armature of the tegumen tends to place this species near *O. perplexus* and its allies, but the central spine is very different in its proportions. In wing form and markings these two species obviously lie rather far apart. A link is that the longitudinal white fascia of the forewings, when present, shows a common tendency to be expanded in basal half and be narrowed in apical part of the wing, suggesting some ancient tie. The markings of the wings might also suggest a relationship with *O. rileyi*, but the subfalcate forewing of the present species is quite distinctive.

The above description and figures were prepared before the paper by Viette became available; the species seems unquestionably to be that described by Viette, but there has been no time for a direct comparison of specimens.

OXYCANUS MAYRI sp. nov.

Plate xxxi, fig. 1-2 and text fig. 20

Male. Antennae pale ochreous, pectinations short, less than 1. Head and thorax dark ochreous-fawn, abdomen pale ochreous-fawn. Forewings pale ochreous-fawn, slightly darker along costa with ochreous suffusions and a broad ill-defined ochreous band from costa at four-fifths to inner margin; there are seven or more transverse rows of brown spots, some larger and with ochreous centres, also a subterminal series of spots each surrounded by an ochreous patch. Hindwings pale ochreous-fawn, slightly darker towards anal angle; traces of a series of subterminal spots; cilia dark fawn. Wing length 26 mm., expanse 56 mm.

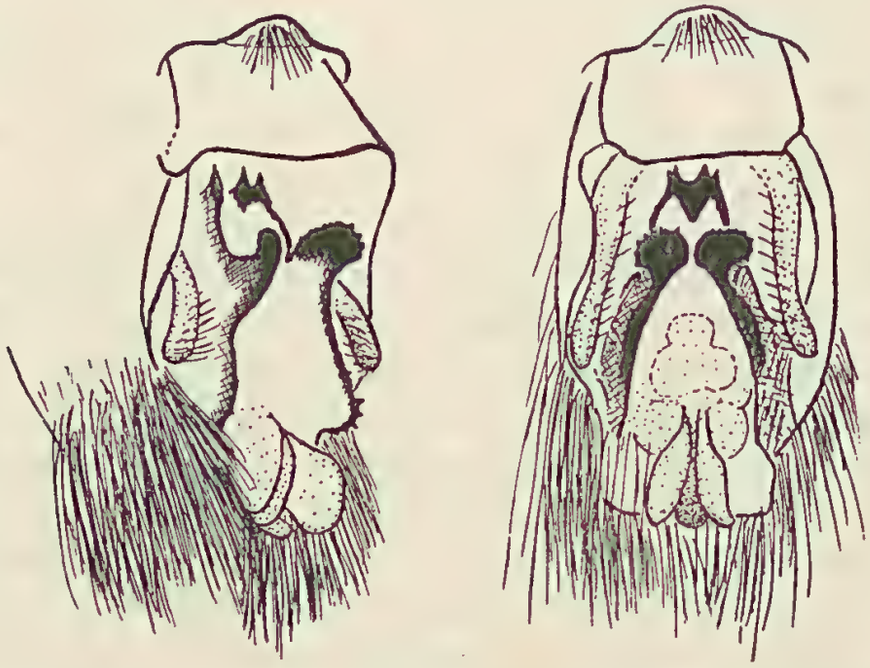


Fig. 20. *Oxycanus mayri* Tindale, Mt. Siwi, male genitalia, oblique lateral and ventral views.

Loc. New Guinea: Mt. Siwi, Arfak Mountains, 800 metres, 13 May, 1928, Dr. E. Mayr. Holotype, a male, in British Museum (ex Tring); there are eight paratype males with the same details. A worn male example, not critically studied, is dated as having been taken 23rd April, 1928, at the same locality.

A paratype specimen (plate xxxi, fig. 2) differs somewhat from the example described above, being superficially similar to the type of *O. perplexus*. As in that species, it possesses a white flash from base to termen of forewing. The hindwing, however, agrees well with the type as also do characters of the genitalia; it seems evident that wing markings follow the same tendency to variation as is met with in many other species of *Oxycanus*.

The male genitalia (fig. 20) have the tegumen much as in *O. perplexus,* but the anterior notched portion is shorter, the central elevation is more conspicuous and in postero-ventral view appears as a dark, serrated, nearly circular plate; there are no large, and only a few small spines on the posterior half of the margin.

OXYCANUS DISCIPENNIS sp. nov.

Plate xxx, fig. 4 and text fig. 21

Male. Antennae ochreous, short, hairy, pectinations short (half or less), palpi projecting beyond frons; head and pronotum pale ochreous-brown, rest of thorax paler; abdomen creamy-fawn slightly more ochreous at base. Forewings pale grayish-brown, rather more gray along costa, with traces of brown spots surrounded by ochreous patches arranged in transverse series across wings; cilia dark fawn. Hindwings pale ochreous fawn with a dusky suffusion extending inward from anal angle between Cu_{1b} and Cu_2 veins; in life the base of wing was probably tinged pink, traces of this remain; cilia dark fawn. Wing length 26 mm., expanse 56 mm.

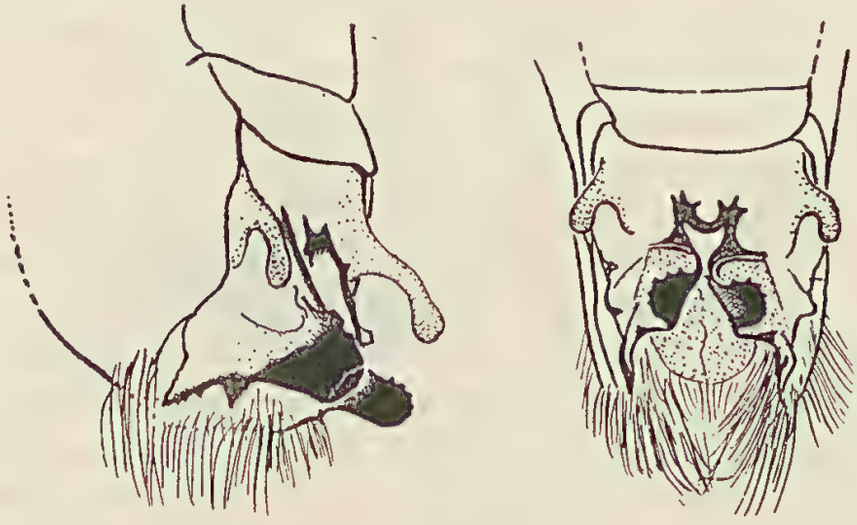


Fig. 21. *Oxycanus discipennis* Tindale, Mt. Siwi, May, male genitalia, oblique lateral and ventral views.

Loc. New Guinea: Mt. Siwi, Arfak Mountains, 800 metres, 13 May, 1928, E. Mayr; type, a male, in British Museum (ex Tring); there is one other available example, a worn male, with same details.

This species was taken at the same time and place as *O. mayri,* of which it, at first glance, might be taken to be merely a variant form in which the forewing markings were partly suppressed. The resemblances in the hindwing

accentuate the similarity. However, the greater degree of rounding of the hindwings appears real, there are no subterminal spots, and the genitalia show marked differences, being especially distinct because of the exaggerated folding of the central eminence of the tegumen. This folding is accentuated by a lateral ridging of the margin between it and the anterior extremity (fig. 21).

In both examples of this species the anterior portion of the teguminal margin is less acutely notched than in *O. perplexus* and *O. mayri;* in the presence of a medium-sized spine and traces of other smaller ones on the posterior part of the tegumen it is closer to the former species. The harpes rise from a broad base to a narrowed median portion which is dilated in a knob-like extremity.

The complex of forms here described as *O. perplexus, O. mayri* and *O. discipennis* have constituted a problem, the complexities of which may, or may not have been solved. All three have points of resemblance, in size, range of markings and general facies, and it is evident that they belong to a closely linked species group. *O. perplexus* and *O. mayri* were taken in the same general area, at slightly different altitudes, 3,500 *versus* 2,500 feet, at periods of the year at least 3½ months apart. Since *Oxycanus* adults have a very brief non-feeding adult life, the emergence period is usually restricted, hence the different emergence periods may have significance. The genitalia are different, although sometimes they require more than superficial examination to establish the differences. Acceptance of *O. perplexus* and *O. mayri* as distinct species on these grounds does not immediately resolve the puzzle because the wing markings in the two species are variable and wing patterns appear to range counter to genital structure. A *mayri*-like form of *O. perplexus* exists as well as a *perplexus*-like form of *O. mayri.* However, the hindwing characters seem to run with genitalia and help to emphasise the distinctive character of the two species.

Although the view that these are all separate species is accepted, there may be alternative explanations. It is possible that the difference between *O. mayri* and *O. perplexus* are only of subspecific value, the isolating factor being *time of emergence* rather than *spatial separation,* since the areas of occurrence are not very far apart.

A third possible view would be that the genitalia themselves are not constant and that all the variant forms belong to one species which also has a wide range in time of emergence. In the case of Australian members of the genus *Oncopera* a similar situation was met, but was resolved on further work, when the forms were proved all to be quite separate species.

The present species, *O. discipennis,* does not assist the solving of the problem and is puzzling in another way. It was taken along with examples of *O. mayri*

at the same time and place. There are some similarities in markings, but the genital structures are very distinct, although they show relationships with those of both *O. mayri* and *O. perplexus*.

OXYCANUS HEBE sp. nov.

Plate xxvi, fig. 8 and text fig. 22

Male. Head and thorax ochreous brown, abdomen pale fawn. Forewings ochreous brown, slightly darker in centre of wing, with two discoidal silvery-white spots, each narrowly margined with black; traces of other dark spots below them, and series of smaller white-centred spots, rimmed with pale fawn, along termen; also a double subterminal series rather irregularly aligned. Hindwings pale fawn. Wings below pale fawn, the hindwings slightly more ochreous-tinged. Forewing length 30 mm., expanse 66 mm.

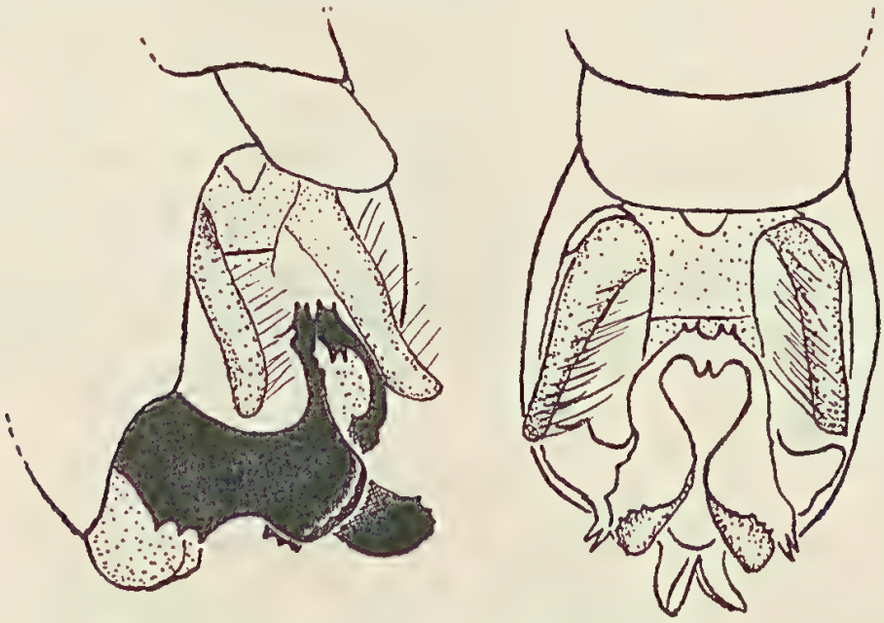


Fig. 22. *Oxycanus hebe* Tindale, Fak Fak, male genitalia, oblique lateral and ventral views.

Loc. New Guinea: Fak Fak, 1,700 feet, January and February, 1908 (Pratt). Type, a male, 1911-117 in British Museum.

Although this species occurs in the same district and altitude as *O. thasus* and is about the same size, it appears about a month later in the season and evidently is quite distinct. Its genitalia (fig. 22) are entirely different in form, possessing a large median expansion on the tegumen which curls inwards and then outwards so that the processes of opposite sides almost meet in the midline. The only available example, unfortunately, lacks its antennae. Without examination of the genitalia the example would probably have been placed with *O. nigri-*

puncta to which it has a close superficial resemblance. It differs in the relatively large size of its forewings and the shape of the short wide hindwings. The genitalia are closest to those of *O. discipennis* but differ in the much enlarged size of the median process on the tegumen and in possessing "normal" harpes rather than the knob-like ones of *O. discipennis*.

OXYCANUS (PARAOXYCANUS) NOVAGUINEENSIS (Viette)

Paraoxycanus novaguineensis Viette, 1950, Zool. Med., Leiden, 31, p. 68, fig. 3 and 8.

Loc. New Guinea: Paniai, 4 September, 1939, taken by the Nieuw Guinea Expedition, K.N.A.G., 1939. Type in Leiden Museum.

The tegumen in this species, which has not been seen, is figured as very similar to that of *Oxycanus tamsi,* described earlier in this paper. In the key given here the species would fall out close to *O. tamsi,* but the harpes appear much shorter in the present species. The two were taken at different times of the year and are different in size and coloration.

ADDITIONS TO AUSTRALIAN SPECIES OF *OXYCANUS*

(See Part III, these Records, v. 5, 1935, p. 280-331.)

Large series of most of the Australian species of *Oxycanus* have been brought together by collectors since the earlier Revision appeared and several additional new species have been discovered; in the main, however, the account of the genus given earlier still holds.

OXYCANUS BYRSA (Pfitzner)

Pfitzner could not have examined this form closely for, despite the different venation, he regarded it merely as a variety of "*Pielus hyalinatus.*" Pfitzner and Grede, in Seitz Macrolepidoptera 10, 1933, p. 834, retained it in *Abantiades.* The late Dr. B. L. Middleton took many specimens at Ebor, New South Wales, in April and May, and it is now a comparatively well-known species; examples exactly matching the type have been taken. The venational patterns and general structure clearly indicate that it is an *Oxycanus.*

OXYCANUS GLAUERTI sp. nov.

Plate xxxii, fig. 1-4 and text fig. 23

Male. Antennae moderate, ochreous, pectinations short, less than 1; palpi brown, smooth-haired, porrect, not long; head and thorax pale brown, abdomen at base ochreous, becoming pale brown at apex. Forewing opaque, dull brown

with scattered yellow scales concentrated along veins, along costa at three-fourths, and in an obscure band from base to outer margin at one-half; there is a silver spot near apex of cell and traces of another nearer to base, the area between them is uniformly brown; there is a marginal series of brown spots between the veins from apex to inner margin, with a parallel submarginal series and traces of still others in the middle of the wing; several of them have traces of silvery-white scales forming centres to the spots. Hindwings pale ochreous at base and along veins, becoming dull brown towards apex. Wing length 26 mm., expanse 56 mm.

Female. Larger, generally gray with a few traces of markings chiefly confined to a small irregular silvery-white spot near apex of cell and a few dark brown scale patches also in the cell; the base of the abdomen and the base of hindwings obscurely ochreous. Wing length 41 mm., expanse 88 mm.

Loc. Western Australia: no specific locality indicated; type, a male, and allotype, female, in British Museum (labelled W. Australia, G. C. Shortbridge, 1906-293); there are seven other examples.

I have pleasure in naming this interesting species after Mr. L. Glauert, who, as Director of the Western Australian Museum at Perth, has done so much for the general study of zoology in Western Australia.

As in so many others of this genus, the wing patterns and colours of the male of this species show considerable variation in detail. The type is well marked and dark; one paratype tends to a pale extreme with the posterior

Fig. 23. *Oxycanus glauerti* Tindale, Western Australia, outline of tegumen in lateral view and of eighth sternite.

three-fifths of the wing yellowish and markings largely suppressed. A third male is much worn but shows a darker phase in which the yellow scales are not as evident.

Examination of the male genitalia will at once identify the species. The tegumen bears three principal spines (fig. 23), a medium-sized anterior one, followed by a slightly smaller one, then a large posterior one, swollen at base and tapering to a sharp spine. The 8th sternite has its hind margin evenly concave.

The simple posterior spine of the tegumen is in marked contrast with the many-spined process found here in *O. determinatus* (Walker), its nearest ally in Western Australia. From that species it differs conspicuously also in the much shorter, rather porrect palpi. Of Eastern Australian species it has, in the male, the most general superficial resemblance to *O. nuptialis* Tindale. Absence of an armed posterior lobe to the tegumen of this species indicates the two are not very closely related.

OXYCANUS KOCHI sp. nov.

Plate xxxii, fig. 5-6 and text fig. 24

Male. Antennae pale fawn, pectinations weak (1½-2); palpi slender, porrect smooth-haired; head and thorax fuscous, abdomen light yellowish-fawn becoming a little darker at apex. Forewings pale ochreous fawn; the costa dark fawn; markings comprise a series of obscure dark fawn spots, one series diminishing in size running from near apex to near inner angle with several obscure blotches of the same colour surrounding white scales on each side of vein R_5. Hindwing rather narrowly ochreous-fawn along costa and on veins, elsewhere fuscous. Wing length 27 mm., expanse 60 mm.

Female. Larger, with elongate forewings uniformly pale grayish-fawn in both wings, with traces of a semi-lunate white patch of scales at apex of cell of forewing. Wing length 40 mm., expanse 87 mm.

Fig. 24. *Oxycanus kochi* Tindale, Australia, outline of tegumen, and of eighth sternite.

Loc. Australia. Type, a male (No. 10797), and allotype, female (No. 10798), in Senckenberg Museum (labelled only as "Australien"); also one paratype, male, labelled "New Holland," in Oxford University Museum.

The abraded condition of the three specimens and their lack of exact provenance has hitherto deterred me from a description. However, the genitalia of the males are distinctive and will enable the species to be readily recognised when further material comes to hand. The similarities in the palpi in the two Senckenberg examples helps to convince me that they are correctly associated as male and female of one species. The lastnamed examples long stood in the

Senckenberg collection under a name label "*hyalinatus* Koch." They are, of course, typical members of the genus *Oxycanus*.

The species appears to be distantly related to *O. nuptialis* and there are some general resemblances, such as the slightly pointed wings of the male and the somewhat elongated wings of the female, but the body build is more robust, the markings less evident, and the genitalia show distinctive features.

The male genitalia have the tegumen with a long anterior projection and also a large bifurcate posterior pair of blunt spines with a straight margin between them (fig. 24). In the key by Tindale (1935, p. 283, *et. seq.*) it would fall on p. 287 under a heading "*gg*. Tegumen with only posteriorly directed post-suspensorial spines or projections."

The very battered Oxford University Museum example seems undoubtedly to belong here, the genitalia, so far as they may be seen without dissection, being identical. The forewings bear more definite silvery-white markings which occupy a roughly V-shaped space near the extremity of the cell and below it. In this detail the species bears a superficial resemblance to the male of *O. niphadias* in which, however, the markings are nearer to the base of the wing. Other markings present include two ill-defined silvery-white spots in the cell.

OXYCANUS ARMATUS sp. nov.

Plate xxxii, fig. 7 and text fig. 25

Male. Antennae and palpi not preserved in available specimen; head and thorax pale fuscous, abdomen yellowish-fuscous. Forewings bright ochreous yellow with pale fuscous on basal half of costa and generally along inner margin; fuscous-margined silvery-white spots forming two parallel series from near apex to inner margin, with two larger angulate markings towards base of wing; there is a series of semi-lunate marginal fuscous marks between the veins along outer margin. Hindwings bright ochreous yellow, almost orange in colour on costa, along outer margin, and on veins, with infuscations between the veins; traces of three outer-marginal fuscous spots. Wings below generally fuscous tinged with ochreous along margins and at base of hindwing. Wing length 34 mm., expanse 75 mm.

Loc. Western Australia. Type, a male, in British Museum (labelled W. Australia, G. C. Shortbridge, 1906-293).

In the key previously published, Tindale (1935, p. 283), this species falls close to *O. poeticus*, although the general appearance is strikingly different, showing, instead of the mixed brown and ochreous colours, a rather uniformly

Fig. 25. *Oxycanus armatus* Tindale, Western Australia, outline of tegumen, and of eighth sternite.

yellow background tint on the forewings and also infuscated hindwings instead of plain reddish-ochreous ones.

The male genitalia differ in the shape and size of the posterior lobe of the tegumen. In *O. poeticus* this is large and subcircular with a margin only feebly serrated, whereas in *O. armatus* this posterior lobe is small, longer than wide, and armed with two large and a series of seven smaller seriate spines (fig. 25).

OXYCANUS SORDIDUS (Herrich-Schaeffer)

Plate xxxii, fig. 8

An extreme form of this species with the silvery markings greatly expanded was taken by Mr. Charles McCubbin at Langwarren, Victoria, in early May, 1947, and through the courtesy of Mr. Nigel Quick I have examined a further series of 10 males and 3 females taken together on 10 May, 1947, ranging from a light brownish-ochreous form without markings on the forewing to the silvery extreme form.

The last named form superficially resembles *O. stellans,* but the base of abdomen and hindwings are almost crimson and the same wings are distally often a dingy gray. The markings of forewings are differently disposed. The tegumen is of typical *O. sordidus* form and readily distinguishable from *O. stellans* by the longer principal spine on the tegumen, the margin of which is shorter than in *O. stellans.*

Three similar examples were taken by Mr. David Holmes at Red Hill, Victoria, on 25th May, 1952. Plate xxxii, fig. 8, shows one of his examples expanding 71 mm. In this the forewings, base of hindwings and body are flashed with a dull reddish-colour, becoming paler towards margins of wings. The silvery markings are widely expanded and edged and lined along veins with dull brown.

SUMMARY

This paper describes and figures fifteen new *Oxycanus* moths of the family Hepialidae from New Guinea, and also three new species from Australia. The status and synonymy of eight previously described New Guinea species is discussed.

EXPLANATION OF PLATES

PLATE XXVI

Fig. 1. *Oxycanus rileyi* Tindale, male, Dohunsehik, type.
Fig. 2. *Oxycanus subochracea* (Joicey and Talbot), male, Wandammen Mts., November.
Fig. 3. *Oxycanus subochracea* (Joicey and Talbot), male, Wandammen Mts., November.
Fig. 4. *Oxycanus thoe* Tindale, male, Wassior, July, type.
Fig. 5. *Oxycanus thasus* Tindale, male, Fak Fak, December, type.
Fig. 6. *Oxycanus serratus* Tindale, male, Wondiwoi, July, type.
Fig. 7. *Oxycanus salmonacea* (Rothschild and Jordan), male, Angabunga River.
Fig. 8. *Oxycanus hebe* Tindale, male, Fak Fak, type.

PLATE XXVII

Fig. 1. *Oxycanus tamsi* Tindale, male, Mt. Goliath, February, type.
Fig. 2. *Oxycanus tamsi* Tindale, male, Mt. Goliath, January, paratype.
Fig. 3. *Oxycanus tamsi* Tindale, male, Mt. Goliath, February, melanic form.

PLATE XXVIII

Fig. 1. *Oxycanus dives* Tindale, male, Mt. Kunupi, type.
Fig. 2. *Oxycanus dives* Tindale, male, ochreous brown form, Mt. Kunupi.
Fig. 3. *Oxycanus dives* Tindale, male, white-streaked form, Mt. Kunupi.
Fig. 4. *Oxycanus dives* Tindale, male, form with markings suppressed, Mt. Kunupi.
Fig. 5. *Oxycanus hecabe* Tindale, male, Hunsteinspitze, February-March, type.
Fig. 6. *Oxycanus hecabe* form *lethe* Tindale, male, Hunsteinspitze, August, type.

PLATE XXIX

Fig. 1. *Oxycanus xois* Tindale, male, Dohunsehik, June, type.
Fig. 2. *Oxycanus xois* Tindale, male, Angi Lake, June.
Fig. 3. *Oxycanus albostrigata* (Rothschild), female, Bolauberg, inland from Huon Gulf, type
Fig. 4. *Oxycanus eos* Tindale, male, Cyclops Mts., type.
Fig. 5. *Oxycanus postflavida* (Rothschild), male, Carstensz Peak, type.
Fig. 6. *Oxycanus fuliginosa* (Rothschild), probably a male, Carstensz Peak, type.
Fig. 7. *Oxycanus salmonacea* (Rothschild and Jordan), male, Angabunga River, type.

PLATE XXX

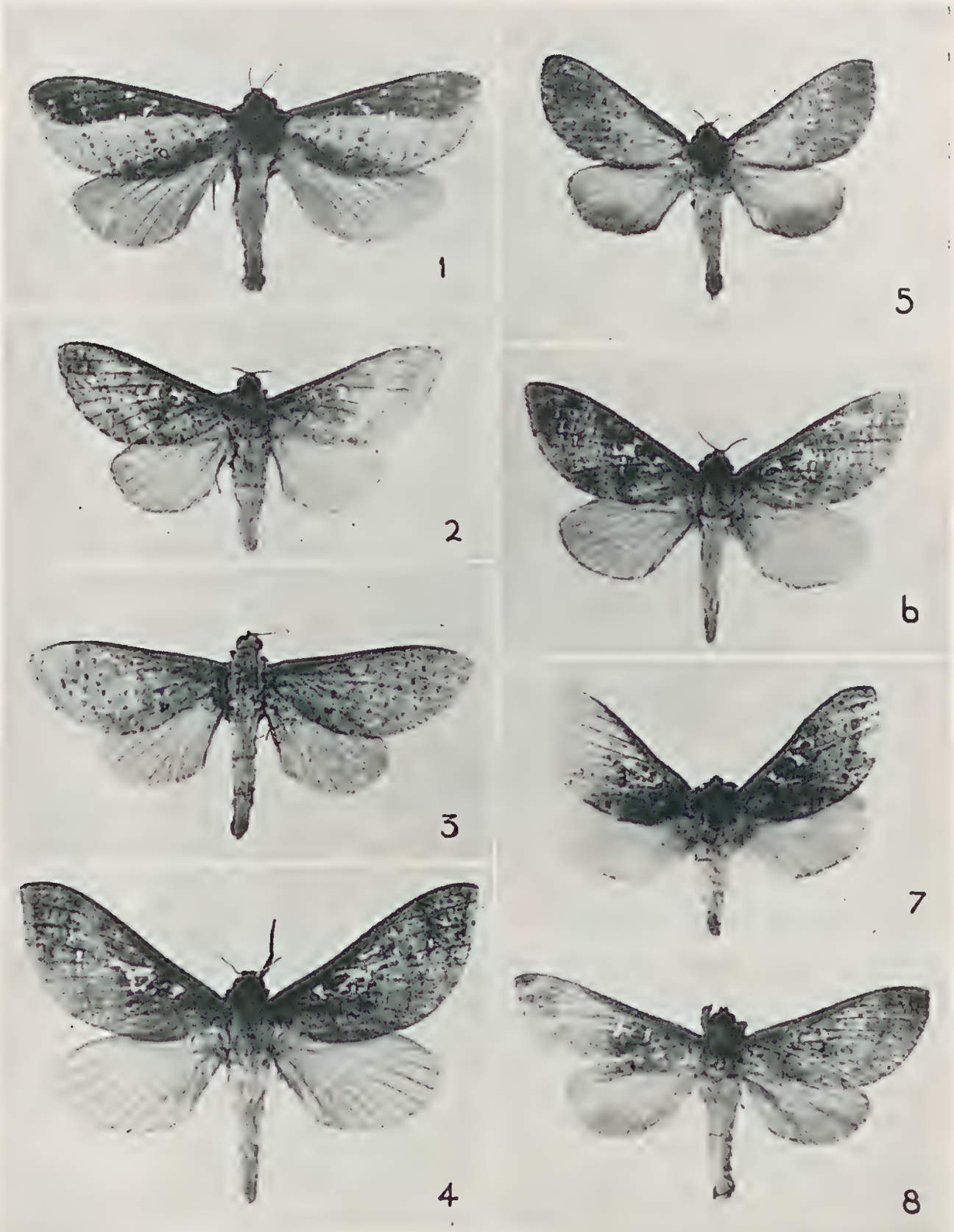
Fig. 1. *Oxycanus meeki* (Viette), male, Biagi.
Fig. 2. *Oxycanus meeki* (Viette), male, Biagi.
Fig. 3. *Oxycanus thoe* Tindale, male, Wassior, July, paratype.
Fig. 4. *Oxycanus discipennis*, Tindale, male, Mt. Siwi, May, type.
Fig. 5. *Oxycanus atrox* Tindale, male, Buntibasa, August, type.
Fig. 6. *Oxycanus atrox* Tindale, male, Buntibasa, August.
Fig. 7. *Oxycanus albostrigata* (Rothschild), male, Rawlinson Mts., allotype.
Fig. 8. *Oxycanus albostrigata* (Rothschild), female, Rawlinson Mts.

PLATE XXXI

Fig. 1. *Oxycanus mayri* Tindale, male, Mt. Siwi, May, type.
Fig. 2. *Oxycanus mayri* Tindale, male, white-streaked form, Mt. Siwi, May.
Fig. 3. *Oxycanus perplexus* Tindale, male, Ninay Valley, form without white streak
Fig. 4. *Oxycanus perplexus* Tindale, male, Ninay Valley, type.

PLATE XXXII

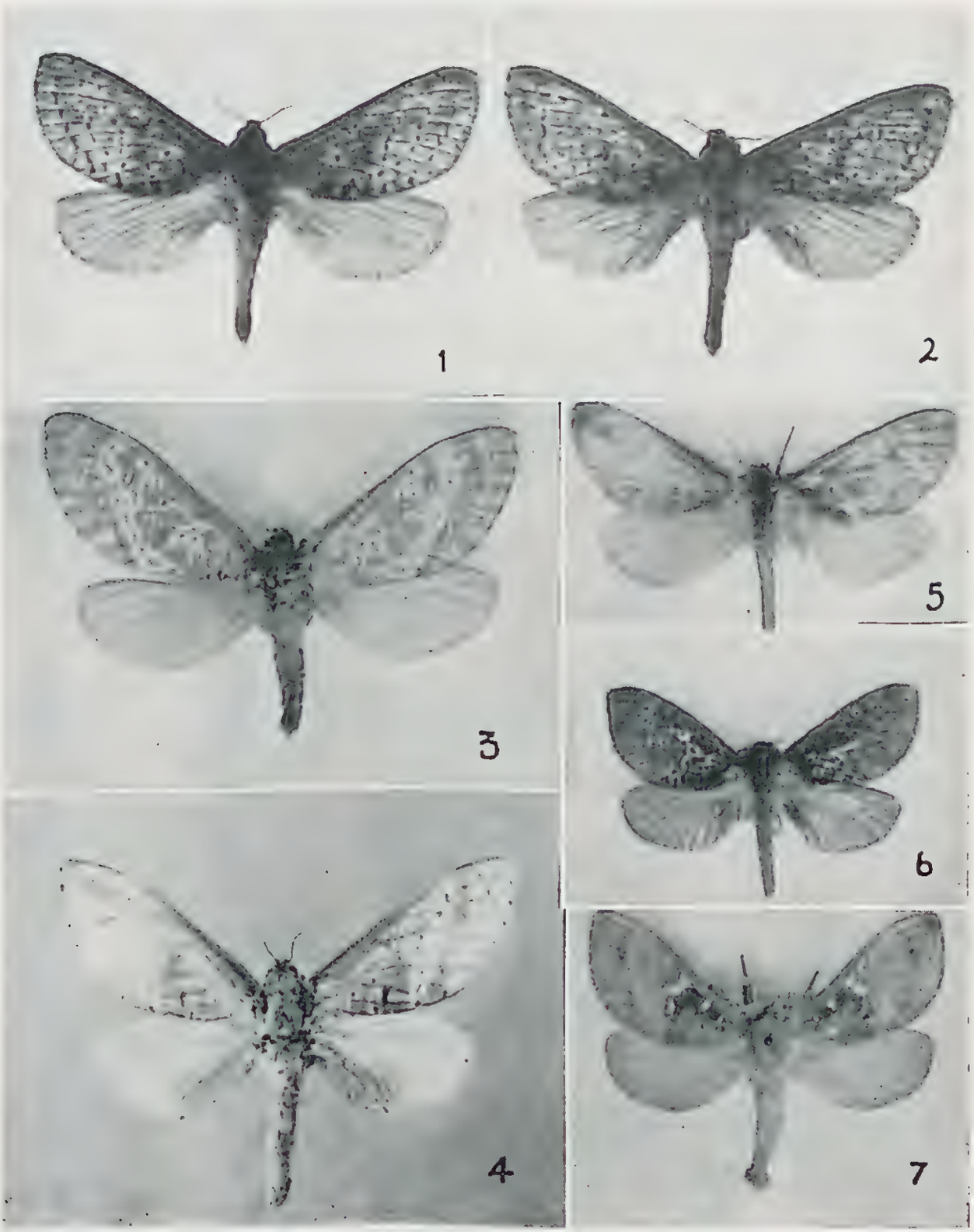
Fig. 1. *Oxycanus glauerti* Tindale, male, Western Australia.
Fig. 2. *Oxycanus glauerti* Tindale, male, Western Australia.
Fig. 3. *Oxycanus glauerti* Tindale, female, Western Australia.
Fig. 4. *Oxycanus glauerti* Tindale, female, Western Australia.
Fig. 5. *Oxycanus kochi* Tindale, male, Australia, type.
Fig. 6. *Oxycanus kochi* Tindale, female, Australia, allotype.
Fig. 7. *Oxycanus armatus* Tindale, male, Western Australia, type.
Fig. 8. *Oxycanus sordidus* (Herrich-Schaeffer), male, silvery-white marked form, Red Hill, Victoria.



NEW GUINEA GHOST MOTHS

NEW GUINEA GHOST MOTHS

NEW GUINEA GHOST MOTHS



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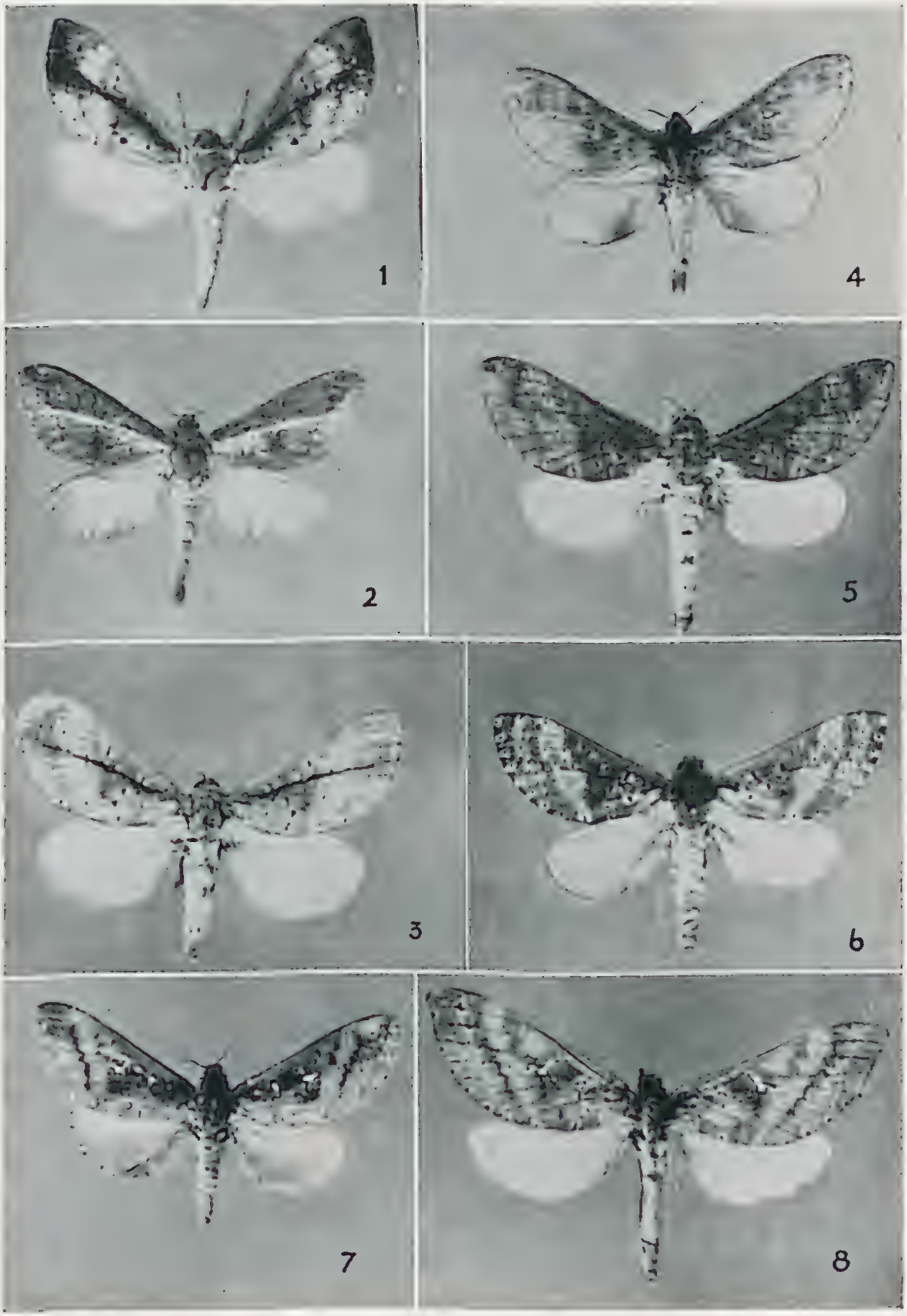

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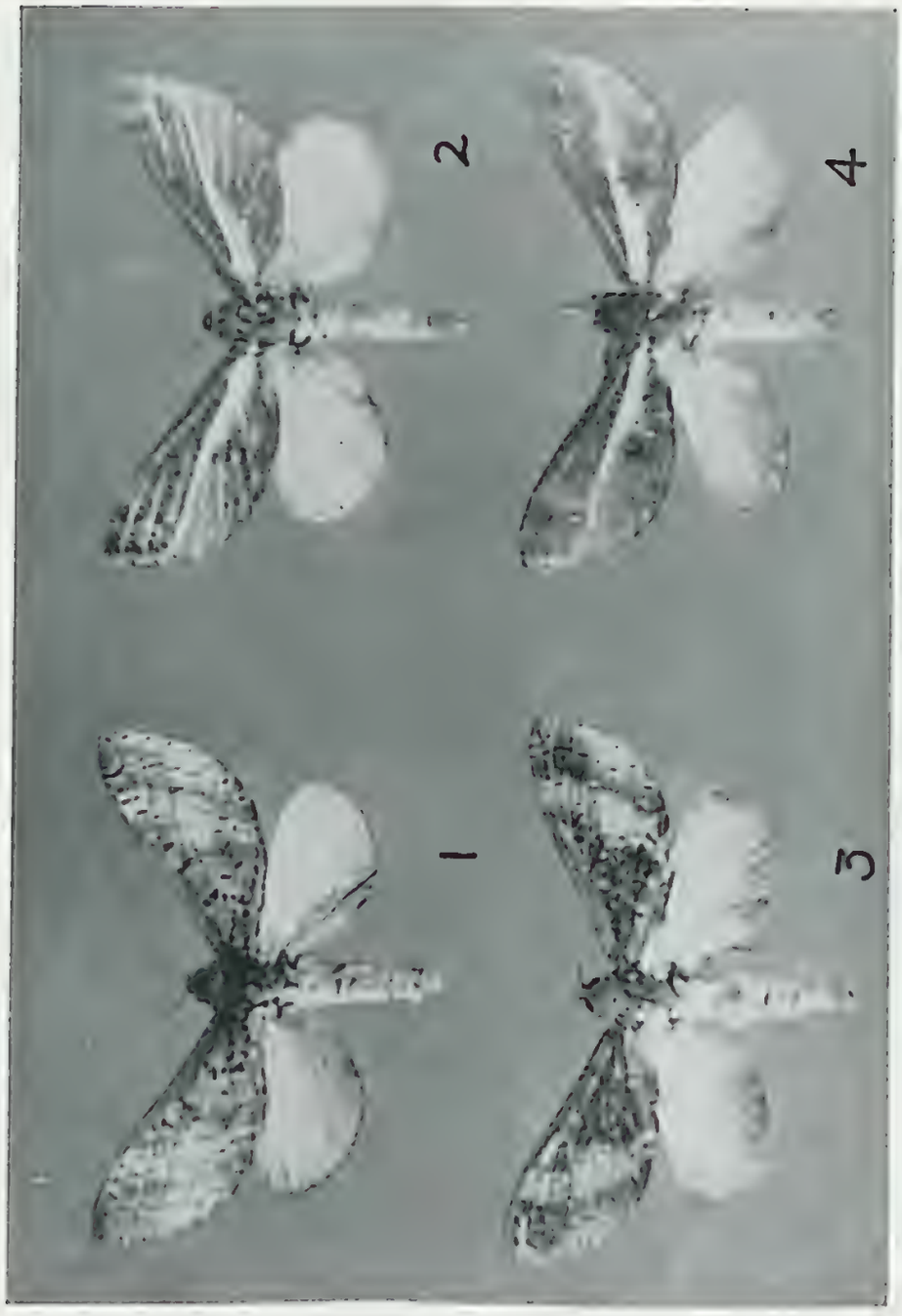
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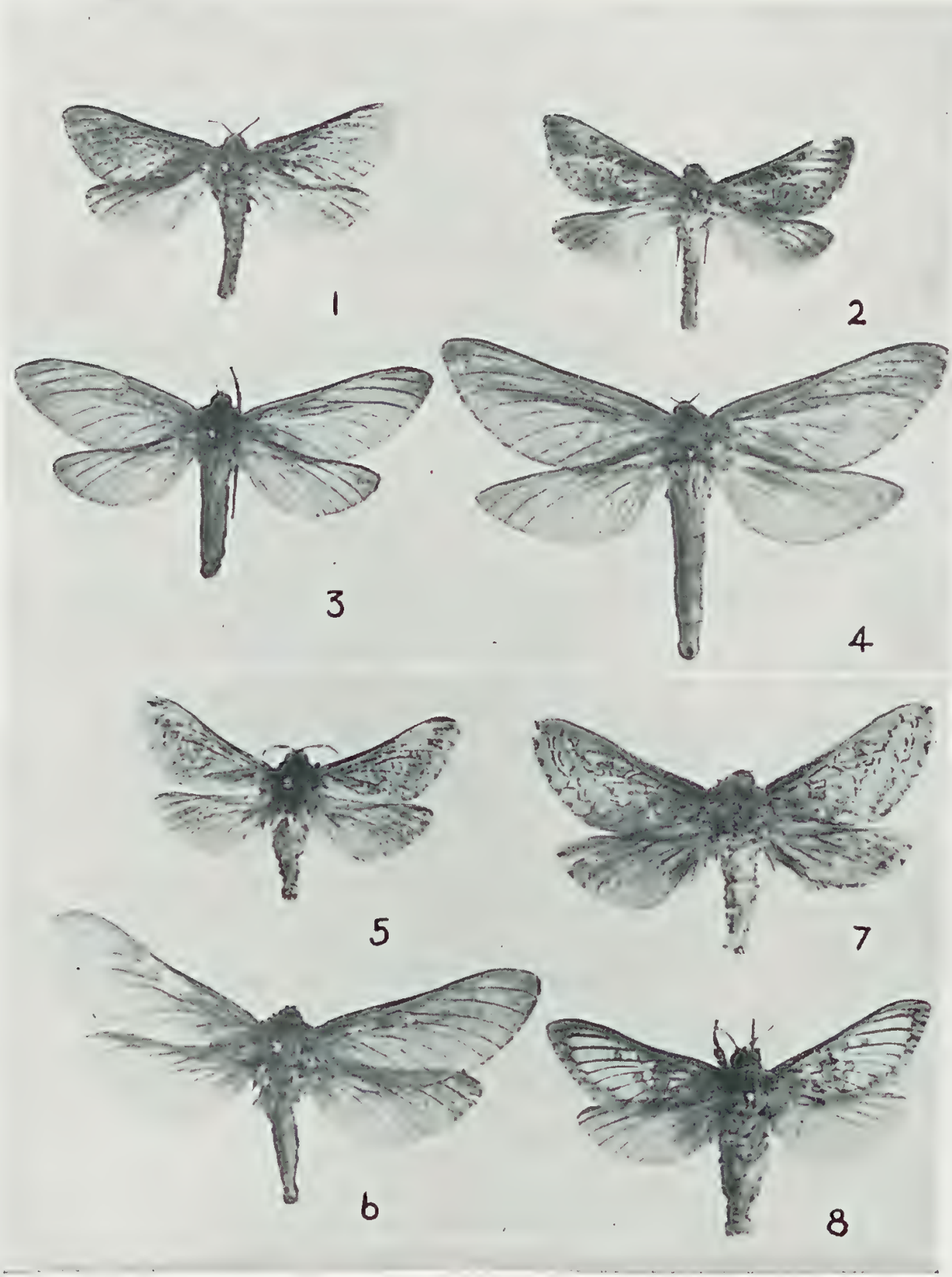

AUSTRALIAN GHOST MOTHS

AN UNRECORDED METHOD OF ABORIGINAL ROCK MARKING

By CHARLES P. MOUNTFORD, Honorary Associate in Ethnology,
South Australian Museum

Plate xxxiii and text fig. 1-5

Only two methods of aboriginal rock markings have been recorded in Australia, (a) the rock engravings on the Triassic sandstone of the Hawkesbury River basin of New South Wales, which consist of outline figures of human beings and creatures cut into the soft rock, some of them up to sixty feet in length, (1) and (b), the pecked or intagliated rock engravings of western New South Wales and South Australia in which the designs, usually of small size, are made up of a series of small pits, close together, probably as the result of blows from a sharp-edged boulder held in the hand (2). The latter type of rock engraving has a wider distribution than at present recorded, the writer having photographed examples of Korporilya Springs and the Iromba rock-hole in the Macdonnell Ranges of Central Australia and at Tomsons rock-hole in north-western Central Australia.

While a member of the 1937 University of Adelaide anthropological expedition to the Granites gold fields and the 1940 expedition to the western deserts of Central Australia, the writer observed aborigines producing rock pictures by a hitherto unrecorded technique.

The Method. In the arid parts of Australia, the exposed rock surfaces are coated with a dark-red patina, which is destroyed when struck with a hard object, exposing the lighter-coloured stone underneath. The aborigines have used this characteristic to produce their simple designs.

In the Granites area, the aboriginal took a small pebble (Plate xxxiii, fig. A and B), and in the Musgrave Ranges, an upper grinding stone (Plate xxxiii, fig. C), and by pounding the surface of the rock produced the light-coloured marks which made up the design.

These rock poundings have a different appearance from that of the intagliated engravings. This difference was strikingly illustrated at the Iromba rock-hole in the Macdonnell Ranges where there were a number of these rock engravings, among them being a series of bird tracks. Immediately below one of these bird tracks some aboriginal had made a copy of one of them by

rock-pounding technique, leaving the pounding tool, an oval boulder, near-by (Plate xxxiii, fig. D).

The eight localities in which rock-pounding designs have been found (excluding the Iromba rock-hole) are indicated on fig. 1. They are the Granites gold fields and Tomsons rock-hole in north-western Central Australia; Mt. Olga, northern Musgrave Ranges, and Kanbi, Tjitibidi, Atalnya and Kuna in the Mann Ranges. The last six localities are in the western deserts of Central

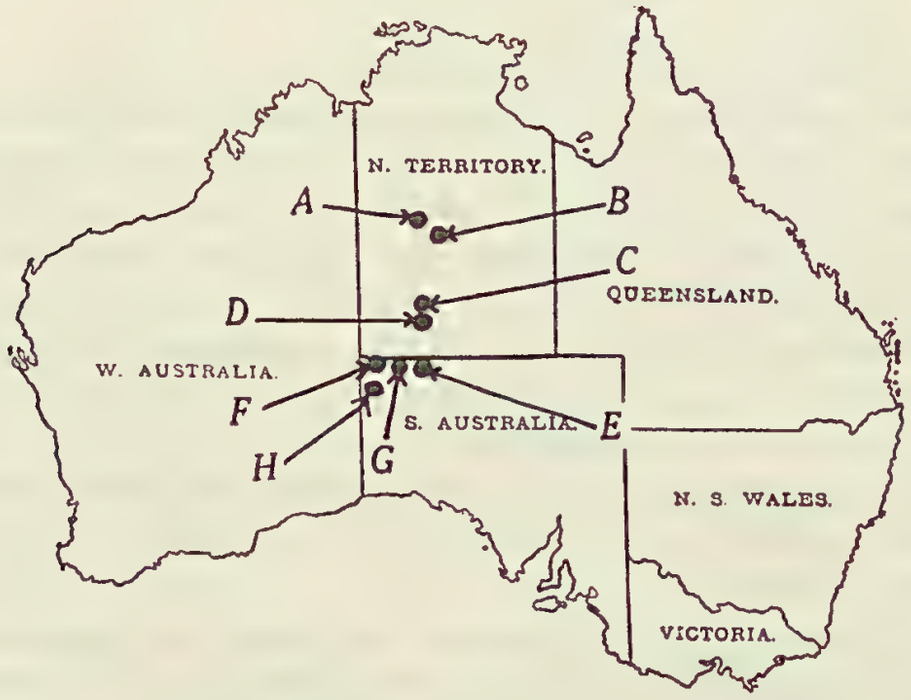

Fig. 1. Localities of rock-pounding designs. A, Granites gold fields. B, Tomsons rock-hole. C, Mt. Olga. D, Northern Musgrave Range. E, Tjitabidi, north-eastern Mann Range. F, Atalnya, north-eastern Mann Range. G, Kuna, northern Mann Range. H, Kanbi, southern Mann Range.

Australia. Further research will almost certainly show that this method of rock marking has a much wider distribution.

The meaning of the designs. It has been possible to find out, from the aborigines themselves, the meanings of a number of designs recorded in this paper. From this it is reasonable to assume that the remainder, even though they have not been deciphered, would have a meaning. They could not, however, be interpreted without the aid of the artist who produced them.

Fig. 2. A, Musgrave Ranges. The circles represent breasts of young girls and the barred double circle the pendant breast of an old woman (Plate xxxiii, fig. C). C, Kanbi, Mann Range. The spiral with radiating lines on the upper edge pictures a ceremonial head-dress. The lower figures were unidentified. D,

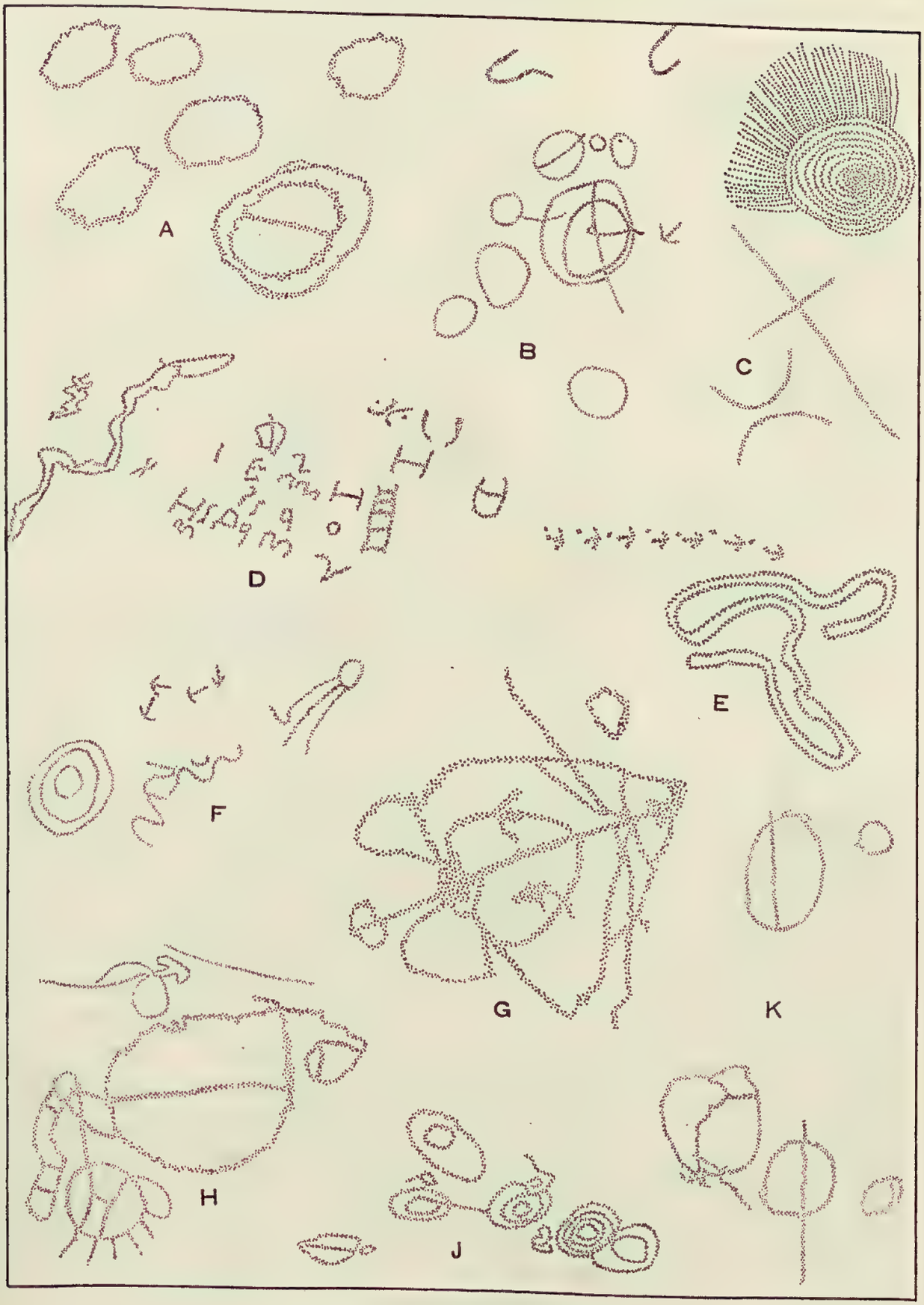

Fig. 2. Rock-pounding designs.

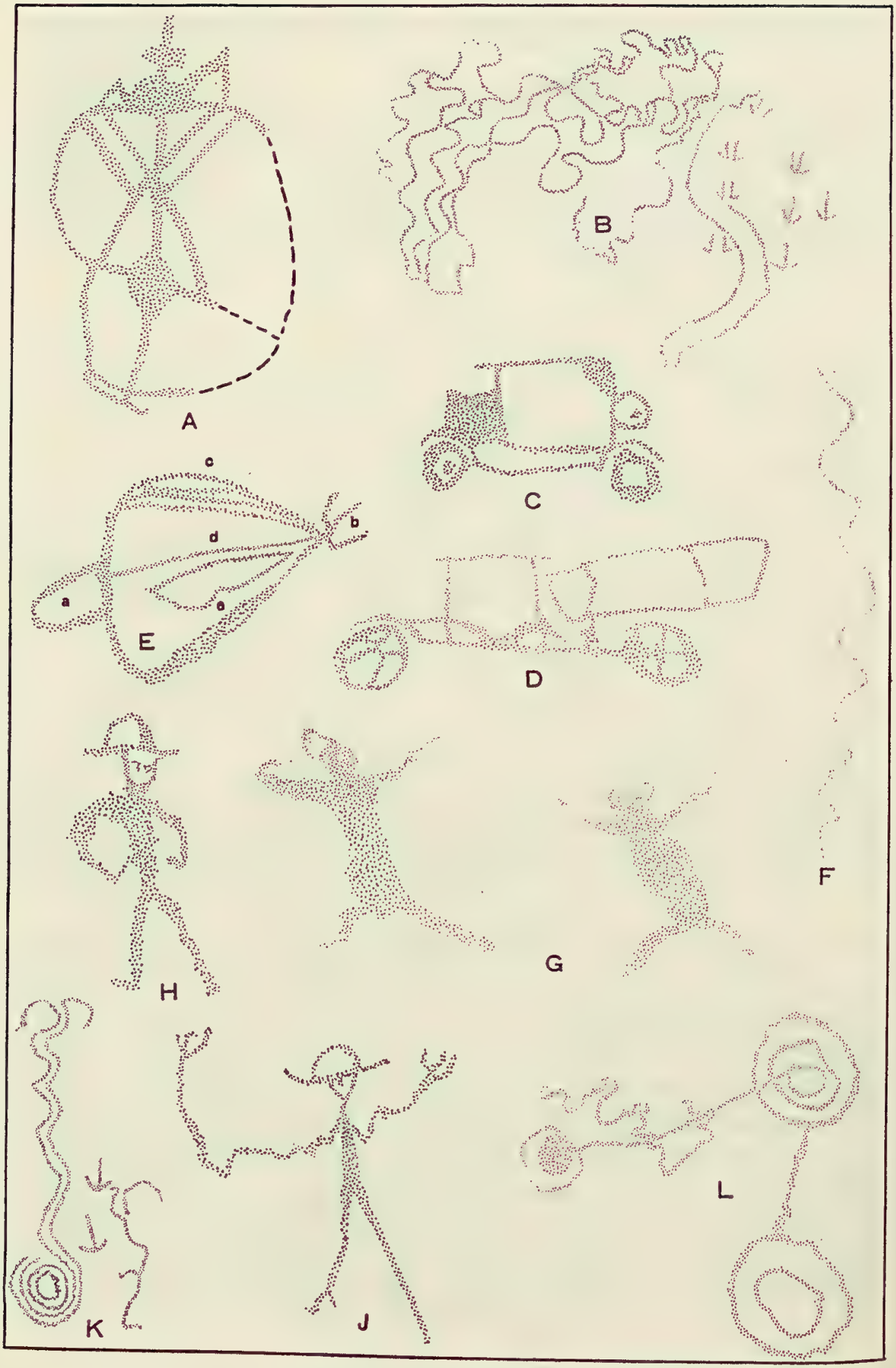

Fig. 3. Rock-pounding designs.

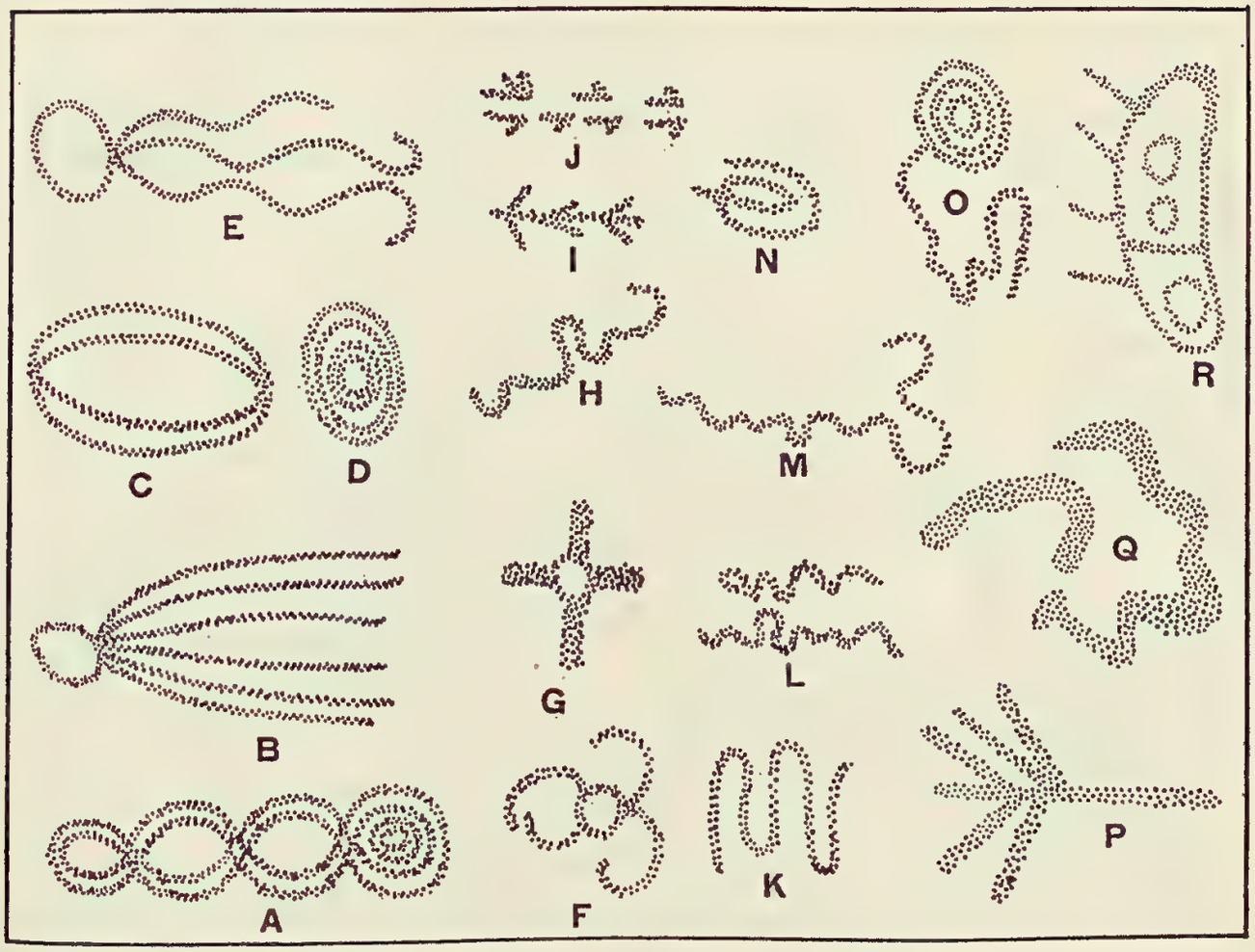

Fig. 4. Rock-pounding designs.

Kanbi. The central group are crude alphabetical symbols made by aboriginal children who had attended a recently-established mission school. E, Tjitabidi, Mann Ranges. An aboriginal, having run an emu down on a hot day, returned to camp at the Tjitibidi rock-hole and commemorated the remarkable feat by pounding a series of emu and human footprints on a tall boulder. The emu footprints indicate the bird he had just captured and the dots his own tracks. The paired meandering lines picture two *wanambi* (rainbow serpents) who, the aborigines believe, live in the near-by Piltadi rock-hole. F, Mt. Olga; B, G and J, Atalnya; and H and K, Kuna, were not identified.

Fig. 3. B, Granites. The meandering lines are the tracks of a mythical snake, *wana,* the paired tracks those of a kangaroo, and the bird tracks a bustard. C, Granites. Motor car. D, Granites. Motor lorry. E, Granites. Totemic map; *a* represents Burgidji, a totemic place adjacent to the Granites, the home of the mythical opossum, *tanumba,* who travelled to Bia; *b,* a place to the south. The lines *c, d, e* symbolize the tracks made by the mythical opossum. F, Granites. Mythical snake, *wana.* G, Granites. The figure on

Fig. 5. Rock-pounding designs.

the right is an old woman, Pundunda, and that on left an old man, Dina. H and J, Granites. Two white men whose hats distinguish them from aborigines. K, Granites. The rock-pounding design is shown on Plate xxxiii, fig. A and B. The meandering lines on the right symbolize two mythical snakes, *wana,* which belong to the area. The loops at the top of the design are their fangs and the double circle at the bottom the hole from which they had emerged. The tracks are those of an unidentified water-bird, *kaliwa,* and the meandering line on the right a small spinifex snake called *wilgibura.* A, Tomsons rock-hole, and L, Granites, were not identified.

Fig. 4. K, L, M, N, Tomsons rock-hole. Snake designs. O, Granites. Snake, *wana,* entering hole. R, Granites. The *waninga* or head-dress of the mythical opossum, *tanumba.* A, B, C, D, E, F, G, I, P, Q, Tomsons rock-hole. Not identified.

Fig. 5. A, Tomsons rock-hole. Simple human figures, meandering lines, abstract designs and kangaroo tracks. D and E, Tomsons rock-hole. Maze designs probably representing the tracks of snakes. C, Tomsons rock-hole, and B, F and G, Kuna, Mann Range, not identified.

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(1) Campbell, W. D. (1899) : Aboriginal Carvings of Port Jackson and Broken Bay.

(2) Mountford, C. P. (1935) : A survey of the Petroglyphs of South Australia. Aust., N.Z. Ass. Adv. Science, pp. 208-215.

EXPLANATION OF PLATE XXXIII

TECHNIQUES OF ROCK-POUNDING

A. Pebble used to produce rock-poundings at the Granites gold field.

B. Aboriginal producing rock-pounding designs at Granites gold field.

C. Aboriginal producing rock-pounding designs at northern Musgrave Ranges.

D. Intagliated rock engravings (outlined) and rock-pounding design at Iromba rock-hole, Macdonnell Ranges.

TECHNIQUE OF ROCK-POUNDING

PELAGIC FOSSILS (ATURIA, PENGUINS, WHALES) FROM THE TERTIARY OF SOUTH AUSTRALIA

By M. F. GLAESSNER, University of Adelaide

Plates xxxiv-xxxvi and text fig. 1-7

INTRODUCTION

The study of the fossil remains of pelagic animals is one of the most promising approaches to the problem of inter-regional stratigraphic correlation. The re-assessment of the relative ages of Tertiary strata in southern Australia which is now in progress, makes it necessary to record all available information on fossils representing pelagic animals, and therefore likely to be encountered in other areas. The four groups discussed in the present contribution, the Cephalopod genus *Aturia,* the penguins, squalodont whales and cetotheriid whales, are approached from different points of view. Ample material of *Aturia* is now available which makes it possible to revise taxonomic concepts and define the regional stratigraphic value of at least two species. The use of *Aturia* for inter-regional correlation will depend on a general revision of its morphogeny and taxonomy, based on direct comparison of specimens from different parts of the world which are traditionally placed in different species of unknown genetic relations.

The discoveries of penguin bones are recorded only from a stratigraphic and biostratonomic viewpoint, and a correction is made in the age determination of the only specimen which had been previously described. A morphological and systematic study of this material will be undertaken by Dr. G. G. Simpson, who is a noted specialist in this field and has better facilities for comparison at his disposal.

A single squalodont tooth is described mainly because of its excellent preservation and obvious differences from all known Australian cetacean teeth. It gives hopes of further discoveries in this field. Because of the rapid and comparatively well-documented evolution of this group, such discoveries will eventually lead to important stratigraphic conclusions.

The re-discovery of a long-lost, exceptionally well-preserved skull of a whale is announced. It is recognized as the first Australian representative of the Cetotheriidae, the ancestors of the whalebone whales. Detailed study and identification of this skull has to be postponed, but it is hoped that the recording of the occurrence will lead to further discoveries in the field.

ACKNOWLEDGMENTS

The writer is indebted to Mr. H. M. Hale, Director, South Australian Museum, for the loan of specimens and for other facilities; to Professors E. S. Hills (University of Melbourne) and R. T. Prider (University of Western Australia) for the loan of material for comparison; to Mr. V. Raghavendra Rao, of the Geological Survey of India, who is at present engaged in research work at the University of Adelaide and who was instrumental in obtaining specimens here described from the Mt. Gambier Limestone; to Miss M. J. Wade (University of Adelaide) for the stratigraphic column of Witton Bluff and photography of specimens, and to Miss M. Boyce (South Australian Museum) for illustrations. This research was assisted by a generous donation from the W. Burdett Fund and by contributions from the General Research Funds of the University of Adelaide.

1. ATURIA IN THE TERTIARY OF SOUTH-EASTERN AUSTRALIA

ATURIA CLARKEI Teichert

Plate xxxiv, fig. 2, plate xxxv, fig. 3 and text fig. 1-3

1919 *Aturia aturi* (Basterot) Newton, Malac. Soc. London, Proc., vol. 13, p. 160, pls. 5, 6.

1939 *Aturia cf. A. ziczac* (Sowerby) Miller and Crespin, J. Paleont., vol. 13, p. 80, pl. 14, fig. 1.

1944 *Aturia clarkei* Teichert, J. Paleont., vol. 18, p. 79, pl. 15, fig. 1-4, pl. 16, fig. 1-2, text fig. 2.

1947 *Deltoidonautilus bakeri* Teichert, Min. Geol. J. Melbourne, vol. 3, No. 2, fig. 1-2.

1947 *Aturia nov. sp.*, Teichert, Min. Geol. J. Melbourne., vol. 3, No. 2.

1949 *Aturia clarkei attenuata* Teichert and Cotton, Rec. S.A. Mus., vol. 9, No. 2, p. 255, pl. 21.

Material. Types: Holotype of *A. clarkei,* U.W.A. No. 21406, paratype U.W.A. No. 21407; holotype of *A. clarkei attenuata* S.A.M. No. P9027, holotype of *D. bakeri* M.U.G.D. No. 1939.*

Other material. Christies Beach-Port Noarlunga section, S.A.M. P5219, P7153, P5944, P5954, P5937 (probably from this locality), A.U.G.D. F15102-5, Maslin Bay A.U.G.D. F15099-101, Campbelltown (north of Adelaide), from a

*The following abbreviations are used for collections in which specimens here referred to are kept: A.U.G.D.—Adelaide University Geology Department, M.U.G.D.—Melbourne University Geology Department, S.A.M.—South Australian Museum, U.W.A.—University of Western Australia Geology Department.

depth of 60 feet in a well, S.A.M. 7017. ?Northern Yorke Peninsula (between Clinton and Ardrossan), A.U.G.D. F15106. This specimen was found without a label in the old collections; its peculiar preservation in a silicified glauconitic limestone with sponge spicules suggests that it came from this area.

Preservation. Most of the 15 new specimens are well-preserved internal moulds of varying sizes, ranging from a diameter of only 35 mm. to a fragmentary large adult specimen with chambers 45 mm. long on the venter. The body chamber is partly preserved in only one specimen. The shell is present only in specimen F15102 in which parts of the surface are perfectly preserved. It is replaced by silica in F15106.

Remarks. *A. clarkei* was fully described by Teichert (1944). The abundant new material shows that it is impossible to distinguish the proposed South Australian subspecies *A. clarkei attenuata* from the Western Australian types in the manner proposed by Teichert and Cotton. The original description of *A. clarkei attenuata* does not enumerate the differences between it and *A. clarkei clarkei,* but the stated resemblances with *A. australis,* i.e., "the general proportions of the shell, particularly the narrowly rounded venter, and slight depression along a ventro-lateral zone," can be taken as indications of its diagnostic subspecific characters, particularly as *attenuata* was regarded as "intermediate between the two species" (Teichert and Cotton, 1949, p. 256). The study of the new material from the type locality and adjoining areas, including specimens more than twice the size of the specimen described by Teichert and Cotton, shows that these characters are not present in adult shells and that at the size of the holotype of *A. clarkei* the venter in the South Australian specimen is less "narrowly rounded" and the depression on the ventro-lateral flanks disappears.

The examination of the fragmentary holotype of *Deltoidonautilus bakeri* showed that the curved "suture lines" figured by Teichert (1947, fig. 3) are not external sutures but oblique sections across the inner portions of the septa on the deeply eroded right lateral surface of the specimen figured in Teichert's fig. 1. Preparation of the other flank revealed the true septa which prove that the specimen belongs to the genus *Aturia.* The apparently angular venter is the result of abrasion. The suture as now revealed (text fig. 1) resembles that of *A. clarkei* in the characteristic shape of the lateral lobe and saddle. In this small specimen they are close-set, but in a large specimen from the same locality, recorded by Teichert as *A. sp.,* they are more widely spaced, as in the typical *A. clarkei* (text fig. 2). Another point of agreement between the holotype of *A. clarkei* and this specimen is seen in the relative position of the tip of the lateral lobe and the ventrolateral shoulders of the ventral saddles of the preced-

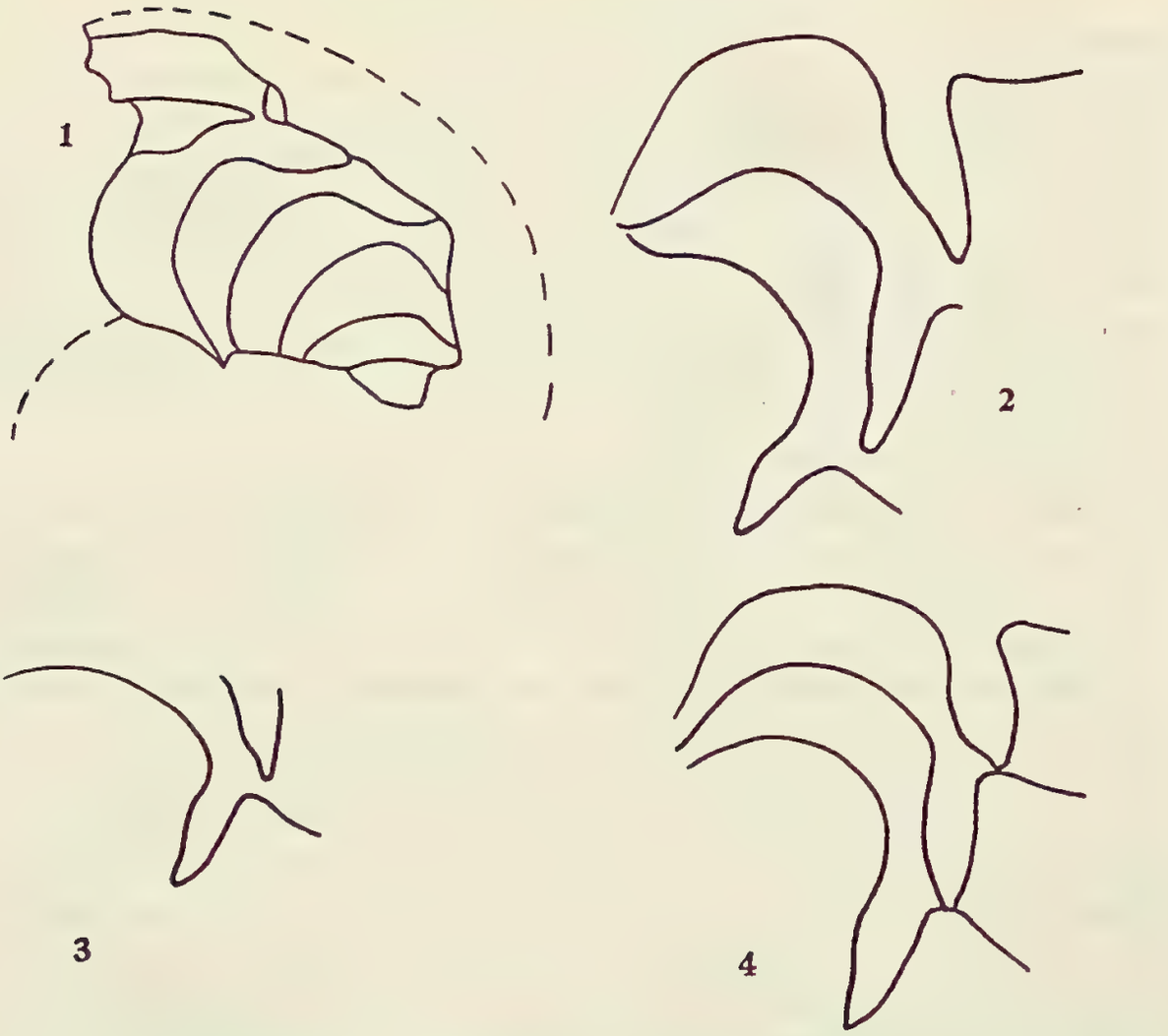

Fig. 1. *Aturia clarkei* Teichert. Suture lines of the fragment described as *Deltoidonautilus bakeri* Teichert, 1947. Diagrammatic. Further preparation has since revealed some additional details.
Fig. 2. *Aturia clarkei* Teichert. Suture lines of the fragment described as *Aturia nov. sp.*, Teichert, 1947.
Fig. 3. *Aturia clarkei* Teichert. Suture lines of holotype.
Fig. 4. *Aturia stansburiensis* Glaessner. Suture lines of holotype.

ing sutures. The tips of the lateral lobes are always placed a short distance towards the ventral side from the rectangular shoulders so that they come to lie against the straight transverse portion of the ventral saddle and the successive suture lines are "staggered" in this region. This is never found in the specimens from the type horizon of *A. clarkei attenuata.* In these the deepest points of the lateral lobes are very sharp and are in line with the sides of the ventral saddles. It is therefore necessary to emend the subspecies *attenuata,* basing it on the character and alignment of the lateral lobes alone. *A. bakeri,* which was based on a fragment, is probably a synonym of *A. clarkei clarkei.* The separation of the subspecies *attenuata* as emended appears to have some biostratigraphic significance as one specimen found recently *in situ* in the Blanche Point Marls at

Blanche Point, and another which comes probably from the equivalents of these marls on Yorke Peninsula (but was not labelled), have the "staggered" arrangement of the suture lines which is seen in the typical *A. clarkei.* The holotype of *A. clarkei attenuata* and all other South Australian specimens listed above which have the lateral saddles and ventral lobes aligned come from the underlying Tortachilla Limestone.

Stratigraphic position and age. Two of the South Australian specimens come from the type locality of the Tortachilla Limestone at Maslin Bay, where they were found just south of the hut known as "Uncle Tom's Cabin" (Reynolds, 1953), about 3 feet above the base of the formation. The specimens from Christie's Beach are also from the Tortachilla Limestone, about 7 miles north of Maslin Bay. The specimen from Campbelltown is preserved in a glauconitic limestone which is the probable subsurface equivalent of the Tortachilla Limestone in the Adelaide Plains Basin, about 22 miles northeast of Christie's Beach. The Tortachilla Limestone grades upward into the "transitional" member of the Blanche Point Marl in which *Hantkenina alabamensis compressa* and other distinctive Upper Eocene foraminifera were found by the late Mr. W. J. Parr. A single specimen of *A. clarkei* with the typical arrangement of septa was found at the top of the succeeding Banded Marl member of the Blanche Point Marls at the southern end of Blanche Point, about 40 feet above the Tortachilla Limestone. The type specimen of *"Deltoidonautilus bakeri"* came from a phosphatic nodule bed near Princetown overlain by strata containing smaller foraminifera which indicate a transition from "Janjukian" to "Balcombian" (Parr in Baker, 1944), *i.e.,* Late Oligocene or Early Miocene age. Teichert considered it and the larger *Aturia* as possibly derived from the Eocene of which lower members are preserved east of the Gellibrand River. The large specimen shows clear signs of wear prior to deposition, as the deeply worn surface of its internal mould is coated with fossiliferous calcareous material.

The Western Australian specimens of *A. clarkei* are probably also of Late Eocene age. I have previously suggested that age for the Plantagenet beds in which Newton's specimen was found (Glaessner, 1953), and the same age is now assigned to the Tertiary strata of the Kennedy Range in which is the type locality of the species (oral information from Dr. R. O. Brunnschweiler).

ATURIA STANSBURIENSIS sp. nov.

Pl. xxxiv, fig. 1a, b

Material. A single well-preserved and undeformed completely septate specimen, partly an internal mould and partly a cast. A.U.G.D. No. F15109, coll. O. S. Rogers, don. Dr. J. Verco.

Occurrence. Stansbury, Yorke Peninsula, in bryozoal limestone.

Description. A large specimen, diameter about 120 mm., maximum thickness about 50 mm., maximum height of last chamber 71 mm., median height of last chamber 50 mm. The shell is not preserved. The whorls are compressed, flattened laterally and narrowly rounded ventrally. The flanks are slightly inflated near the inner and compressed near the outer third of their height. There are 14-15 chambers in the last whorl. The sutures are shaped as in *A. clarkei,* and show the "staggered" arrangement described above.

Comparison. This form differs from *A. clarkei* clearly in the shape of the conch which is much more laterally compressed and has a more marked ventrolateral compressed zone. The chambers are shorter and more closely set. Otherwise the septation does not deviate from the typical shape of the suture in *A. clarkei.* It differs from *A. australis* in the shape of the suture line.

Stratigraphic position and age. This species comes from a bryozoal limestone which is the equivalent of the Port Willunga Beds of the Maslin-Aldinga Bay standard section. The typical foraminiferal fauna of the Port Willunga Beds with *Sherbornina* was found at Stansbury but has not yet been described. The age of these beds is considered as Late Oligocene.

ATURIA AUSTRALIS McCoy

Pl. xxxv, fig. 1a, b and 2

1944 *Aturia australis* McCoy, Teichert, J. Paleont., vol. 18, p. 73, pl. 14, text fig. 3.

Material. 1. Muddy Creek, Victoria, A.U.G.D. No. 15108. 2. Naracoorte Quarries, South Australia, S.A.M. No. 10544, No. 8810, and probably also A.U.G.D. No. F15097-8 (received without label from Kingston School). Both collections include partial internal moulds of several specimens. 3. Table Cape, Tasmania, M.U.G.D. No. B118. 4. Mt. Gambier, South Australia.

Preservation. The specimens from Muddy Creek are mostly perfectly preserved shells. Those from Naracoorte are mostly large internal moulds which are perfect and not compressed, but tend to become disjointed. The specimen from Table Cape is a fragment of an outer whorl of a large conch with the chambers ventrally up to 40 mm. long. Only an internal mould of a single chamber is available from Mt. Gambier.

Remarks. The characters and affinities of this species were recently discussed by Teichert, who showed that an orally directed bulge in the septum just above the siphuncular orifice, the even curvature of the lateral saddle (Teichert, 1944, fig. 2, 3), and the compressed shape of the conch distinguish this species

from *A. clarkei*. Nothing can be added to his detailed description except the observation that the distinguishing characters are also clearly recognizable in internal moulds. The only new record is that from Naracoorte.

Stratigraphic distribution and age. Teichert had restricted the stratigraphic range of *A. australis* to Miocene, following Singleton. This is undoubtedly correct for its type locality, Muddy Creek, and for Beaumaris, in Victoria. Teichert questioned the New Zealand records which have since been eliminated, with the exception of a Late Oligocene or Early Miocene *"A. cf. australis"* (Fleming, 1945). Teichert also doubts the correctness of the record from the Gellibrand River, but neither this material nor the specimens from Brown's Creek to which Chapman referred are available for re-examination. The species also occurs at Spring Creek near Torquay (Victoria), Table Cape (Tasmania), and Mt. Gambier (South Australia). At all these localities a foraminiferal fauna which is older than that from Muddy Creek was found and the age of the strata is probably late Oligocene. The age of the limestone at Naracoorte has not yet been established, but it is probably not much younger than the Mt. Gambier limestone. *A. australis* has not been found in the Eocene where *A. clarkei* occurs. The relationship between the two species is therefore not one of contemporaneity in different areas, but one of substitution in time. This should make them most valuable index fossils.

2. THE OCCURRENCE OF TERTIARY PENGUIN REMAINS IN SOUTH AUSTRALIA

In 1938 Finlayson described the first fossil penguin bone from Australia, a left humerus, which he named *Palaeeudyptes cf. antarcticus* Huxley. Three more penguin bones have been found recently in the Tertiary of South Australia. Pending description and identification of these remains, which will be undertaken by Dr. G. G. Simpson at the American Museum of Natural History where the necessary comparative material is available, only a record of their discovery and stratigraphic relations is included in the present communication.

The first specimen was found by W. Burdett at Witton Bluff, at the southern end of Christie's Beach, about 16 miles south of Adelaide. The description given by Mr. Finlayson was based on the lateral (external) aspect of the bone (S.A.M. No. P7158). It has since been freed from the matrix which is a soft glauconitic marl. It comes from the "Transitional Marl" Member which forms the base of the Blanche Point Marls and overlies the Tortachilla Limestone at this locality as it does at Maslin Bay 7 miles further south (Reynolds, 1953), where W. J. Parr found *Hantkenina alabamensis compressa* and other Upper Eocene

foraminifera in the Transitional Marl. The foraminiferal faunas from this locality and from the matrix of Finlayson's *Palaeeudyptes* show close agreement. Their investigation is proceeding. Howchin had incorrectly considered the marine sequences at these localities (below transgressive Pliocene) as Miocene.

In 1952 I found another penguin bone, a right tibiotarsus (S.A.M. No. P10862) *in situ* just below the top of the Banded Marl Member of the Blanche Point Marls north of Port Noarlunga Jetty, at the base of the cliff extending southward from Witton Bluff, at high water level. This bed is, according to Miss M. Wade who mapped and measured the cliff section, about 20-25 feet above the Transitional Marl. There is no significant change in the foraminiferal fauna and the age of the bed is probably Late Eocene. The proximal end of the bone was eroded away by the sea and the distal end as found in the rock matrix was incomplete, probably because of weathering prior to embedding. The shaft of the bone is well preserved.

A third bone (pl. xxxvi, fig. 1a, b), a right humerus (S.A.M. No. P10863), was received soon afterwards from Mr. P. Pritchard, of Mt. Gambier. Mr. Max Pritchard had found it in Pritchard Brothers' building-stone quarry about 7½ miles west-north-west of the town of Mt. Gambier. It was completely embedded in bryozoal limestone but the distal end was lost when a block of stone was cut during quarrying operations. The proximal part is completely preserved but its surface is worn. When the matrix was carefully removed from the surface of the shaft of the humerus it was found marked with several deep grooves running across it obliquely on both sides. They are sharp-edged, narrow, and slightly irregular on the external side, and shallower, with more rounded edges, on the internal side. They are obviously injuries inflicted by some animal, either in connection with or subsequent to the death of the penguin. They were infilled with bryozoal limestone matrix. The contrast between the sharp somewhat splintered cuts on one side and the corresponding smoother depressions on the other could be due to slight abrasion of the upper surface by current-driven sand on the sea floor prior to complete embedding. This was suggested to me by Mr. P. Lawson, of the South Australian Museum. It is thought that the parallel cuts were made by the bite of a shark or a squalodont whale. Large sharks' teeth occur in the Gambier Limestone, and the tooth of a *Squalodon,* found at the same time as this bone, is described below.

The fourth penguin bone, a small left femur (S.A.M. No. P10870) was found and presented to the writer by Mr. D. J. Leonard, of Adelaide, who discovered it while working on the surface of a Mt. Gambier building stone block. It was taken from the matrix undamaged, but both ends showed signs

TABLE 1

Age	*St. Vincent Gulf Area* °	*Foram. Faunas*	*Aturia*	*Penguins*	*Whales*	*Murray—Mt. Gambier Area* *	*Victorian Stages*
Lower Miocene		3			**Aglaocetus? n. sp.*	"Murravian"	"Batesfordian"
——?——	Port Willunga Beds	2	**A. australis* °*A. stansburiensis*	*Spec. 10863 and *Spec. 10870	**Squalodon gambierense* and **Parasqualodon wilkinsoni*	Gambier Limest.	"Janjukian"
Oligocene	Chinaman's Gully Beds						
——?——	Blanche Point Marls					Knight Group	
Upper Eocene		1	°*A. clarkei clarkei*	°Spec. 10862 °Spec. 7158			
	Tortachilla Ls.		°*A. clarkei attentuata*				

of wear and weathering prior to embedding. Bryozoal colonies were found in growing position attached to the surface of the bone. The proximal part was deeply splintered with a V-shaped edge, suggesting that this part may have been bitten off. Abrasion would have removed the projecting *caput femoris* rather than an adjoining triangular portion.

The Gambier Limestone, a thick-bedded aggregate of coarse bryozoal, echinoderm and molluscan fragmentary and complete specimens, is younger than the Blanche Point Marl and corresponds in lithology and general character of its foraminiferal fauna (which is being examined) to some of the Port Willunga Beds of the Maslin-Aldinga Bay Section. Typical Eocene and Miocene foraminifera are absent and the age of the deposit is considered as Oligocene. It rests unconformably on the paralic (intermittently marine) sands and clays of the Knight Group.

The stratigraphic position of the four penguin bones is shown in Table 1.

3. A CETACEAN TOOTH FROM THE GAMBIER LIMESTONE

SQUALODON GAMBIERENSE sp. nov.

Text fig. 5a-c

Material. One isolated perfectly preserved molariform tooth, probably from the right mandible.

Occurrence. Gambier Limestone, Pritchard Brothers' quarry, about 7½ miles west-north-west of Mt. Gambier. Presented by Mr. P. Pritchard, of Mt. Gambier, 1952.

Age. Probably Late Oligocene.

Holotype. A.U.G.D. No. F15107.

Diagnosis. The species is based on a compressed molariform tooth in which both cutting edges are denticulate, the median cusp is large, the enamel is smooth on the labial and finely vertically ridged on the lingual side near the base; the roots are widely separated below a thin isthmus.

Description. The tooth, which is unworn, shows a compressed, triangular, denticulate crown and two widely separated roots which are joined below the crown by a thinner lamina ("isthmus") to about one-third of their length. The crown ends in a strong median point which has a long curved anterior and a shorter almost straight posterior cutting edge. The anterior edge of the tooth shows three denticles decreasing rapidly in size downward. The first (upper) resembles the median point in shape but is much smaller. The second and third

are conical. The cutting edge which is pronounced on the first and second denticle vanishes on the third. In some places, such as the base of the main point and the anterior edge of the upper denticle, is seems to show a minute secondary denticulation. The posterior edge of the tooth shows four well-developed denticles which decrease regularly in size downward, and a minute trace of a fifth. The cutting edge extends to the posterior end of the fourth denticle and shows a fine secondary denticulation on the posterior edge of the third. The maximum antero-posterior diameter of the tooth lies above the base of the crown, owing to the pronounced curvature of the edges of the third anterior and fourth posterior denticles. The general outline of the crown is broadly triangular, the points of the denticles being directed upward rather than

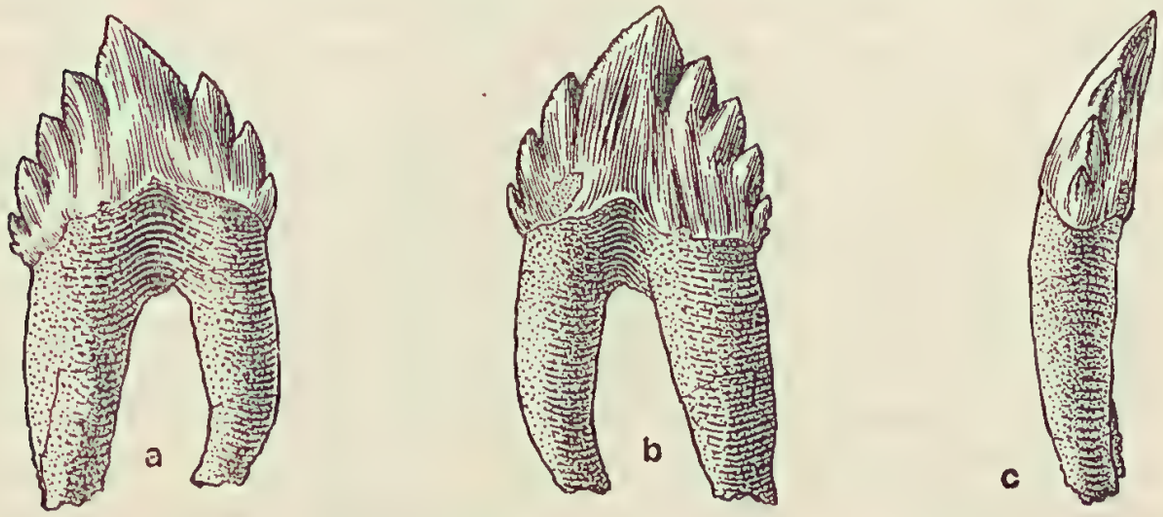

Fig. 5. a-c. *Squalodon gambierense* Glaessner. Holotype. *a*, labial view; *b*, lingual view; *c*, anterior view. Nat. size (approx.).

forward or backward. The bases of the denticles are separated by pronounced "valleys" extending up the slopes of the crown. There is also a short, wide, median depression leading from the centre of the crown towards the isthmus. On the labial side the surface of the enamel is perfectly smooth and only slightly fluted by the "valleys" between the denticles. On the lingual side there are faint straight vertical rugosities which converge in the direction of the main point and disappear without reaching it. They do not form any prominent projecting points on the surface. The base of the enamel crown is a sinuous line, faintly S-shaped above each root base and rising to an angular deep embayment labially and a rounded shallower embayment lingually. The roots are constricted below the crown, with irregular shapes and roughly triangular transverse sections. The maximum antero-posterior diameter of the posterior root exceeds that of the

anterior root, but there is little difference between their transverse diameters. The distance between the roots varies little though the lower end of the anterior root is slightly curved backward. The isthmus ends below in a sharp edge which is pierced in the middle by a pin-hole opening.

Measurements. Antero-posterior diameter (maximum) 30 mm., antero-posterior diameter at base of crown 27·4 mm., median height of crown on lingual surface 22·0 mm., median height of crown on labial surface 20·3 mm., maximum height of crown (from lowest level of enamel vertically to main point) 26·0 mm., maximum thickness of crown 11·0 mm., length of isthmus (labial) 12·5 mm., length of isthmus (lingual) 9·0 mm., length of anterior root over 30 mm., length of posterior root over 29 mm., transverse diameter of roots about 10 mm., antero-posterior diameter of posterior root 13·2 mm., antero-posterior diameter of anterior root 10·1 mm., maximum antero-posterior diameter at maximum convexity of roots 29·2 mm., same immediately below crown 27·2 mm., total length (height) of tooth as preserved 54 mm.

Discussion. In 1881 Sanger established the species *Zeuglodon harwoodi* on a molariform serrate tooth "and the fragments of a second" which was left undescribed. The type material seems to have been lost (Hall, 1911). It came from a fossiliferous yellow calcareous clay on the River Murray near Wellington, South Australia. None of the fossils from that locality as named by Sanger, who considered them as "Eocene," gives any definite indication of age, but they are definitely pre-Pliocene. The accompanying fauna consisted of sharks, *Aturia,* lamellibranchs, gastropods, and echinoids. The exact locality is not known. The tooth is compressed and rather small, the antero-posterior diameter being 23 mm. and the median height of the crown 19 mm. There are four denticles on the anterior and six on the posterior edge. The median cusp is not much larger than the adjoining lateral denticles. The surface of the enamel is not described in the text but appears smooth in the drawing which is probably correct. Coarse rugosities such as appear on other Australian squalodont teeth would have attracted the author's attention and would have been mentioned in his otherwise detailed description. The roots are broken off below a thin connecting "isthmus" and the author was "inclined to think that possibly the isthmus was wanting in the portion broken off, so that the pillars became two distinct fangs" (p. 299). These details are important in the interpretation of this fossil.

The species was discussed by Hall (1911), who attributed to it a tooth from Mt. Gambier on account of a similarity in the thickness of the roots which he considered as different from those of *Parasqualodon wilkinsoni* McCoy. He

thought that "such a marked difference in the proportionate size of the roots would probably be correlated with differences in the strength of the jaws" (p. 258) while he considered the "variation in the ornament" as less important. On that basis he established the genus *Parasqualodon* for McCoy's species and the genus *Metasqualodon* for Sanger's species, describing it as follows:

"Roots of molariform teeth slender and only a little longer than the height of the crown, the two fangs connected by a thin 'isthmus' much as figured by Lydekker in *Prosqualodon*, but the fangs more nearly approaching one another. The material does not inform us as to whether the fangs were connected throughout their length by the isthmus, or whether they projected freely beyond it. Lateral cusps rather large. Ornament as in *Parasqualodon*."

This generic description is obviously influenced by Hall's assignment of the tooth from Mt. Gambier (in the National Museum of Victoria) to Sanger's species. The study of more complete remains of toothed whales shows clearly that Hall's basic assumption was wrong and that the ornamentation of the surface is a valid taxonomic character while the "proportionate size of the roots" depends on the position of the teeth in the jaws. Kellogg (1923, p. 20) stated: "The ornamentation of the enamel crown (of the tooth from Mt. Gambier) suggests a closer relationship with *Parasqualodon wilkinsoni*. In that case this tooth represents one of the posterior premolars." Flynn (1948) fully described a fine skull of *Prosqualodon davidi* and on this occasion revised Hall's identifications. This led to the following revision of the legend to Hall's plate 36:

	Hall	Flynn	Locality
Fig. 1	*?Parasqualodon wilkinsoni*	?	Waurn Ponds
Fig. 2.	„ „	*Prosqualodon davidi*	„ „
Fig. 3.	„ „	„ „	Spring Creek
Fig. 4.	„ „	„ „	Table Cape
*Fig. 5.	„ „	*Parasqualodon wilkinsoni*	Castle Cove
Fig. 6.	*Metasqualodon harwoodi*	*?Parasqualodon wilkinsoni*	Mt. Gambier
*Fig. 7.	„ „	*Metasqualodon harwoodi*	Wellington

(Figures of holotypes are marked in the above list with *.)

Though neither Kellogg nor Flynn are quite definite in assigning the tooth of Hall's fig. 6 to McCoy's species, it obviously does not belong to *Metasqualodon* or to Sanger's species. The genus *Metasqualodon* rests therefore on the lost

specimen from Wellington only, and until another similar specimen is found it cannot be redefined or properly understood. The new tooth from Mt. Gambier resembles Sanger's fig. A (=Hall's fig. 7) only in the smooth crown, but differs in the size and number of denticles and particularly in the very large size of the main cusp. Its substitution as a neotype of *Metasqualodon harwoodi* would not be justified.

Abel (1913) had tentatively placed *Zeuglodon harwoodi* in the genus *Microzeuglodon* Stromer (Type *Zeuglodon caucasicum* Lydekker). The discovery of a new specimen from the Oligocene of the Caucasus, belonging or at least closely related to Lydekker's species (Rjabinin, 1938) proved that the skull of the Caucasian form has the character of the Archaeoceti and not that of the squalodontids. Abel had proposed the establishment of a family Microzeuglodontidae within the Archaeoceti. A distinction between Archaeoceti and Squalodontidae on the basis of isolated teeth is difficult but not impossible, and perhaps not very important if there has been a gradation from the older to the younger group as some authors postulate. The differences in the teeth have not been clearly stated, but in his description of *Kekenodon onamata* Hector, Kellogg (1923, p. 27) says: "The unusual appearance of the accessory cusps, the character of the enamel surface of the crown, and the large size of the teeth are peculiarities which place this form among the zeuglodonts. Such features are unknown for any squalodont." He assigned to the Archaeoceti *Phococetus vasconum* (Delfortrie), which was based on a single tooth, as their youngest representative (Lower Miocene). The appearance of the accessory cusps and the character of the enamel surface, revealed by further preparation of the holotype, which will be redescribed elsewhere, place *Squalodon serratus* Davis (Lower Oligocene, White Rock River quarries, Okuku River, North Canterbury, New Zealand) in the vicinity of *Kekenodon,* but it is much smaller than any of the teeth of *K. onamata.* It had been suggested by Flynn (1948, p. 186) that Davis' species might belong to *Parasqualodon wilkinsoni* McCoy, but this proved to be incorrect.

The new tooth from Mt. Gambier differs in the character of the accessory cusps, the main cusp, the enamel surface and the roots from all these genera and species, including *Parasqualodon* and *Prosqualodon.* Although it resembles typical Archaeoceti such as *Dorudon* in the outline of the crown and the separation of the roots, it is smaller and much more compressed and resembles more closely species of the genera *Neosqualodon* and *Squalodon.* The teeth of *Neosqualodon* are much smaller. The teeth of *Squalodon* are often of the size of the present specimen, but in most species their surface is more rugose. It is signi-

ficant that a species distinguished mainly by smooth enamel, *S. dalpiazi,* was recently described by Fabiani (1949). He has also shown that the roots of *S. scillae* (Agassiz) (*S. melitensis* Blainville sp. in Kellogg, 1923) are straight and not convergent at their lower ends. The median cusps of molariform teeth of *Squalodon* are often strongly developed, as in the present species. For these reasons it is best assigned to the widespread genus *Squalodon,* though confirmation from at least the discovery of complete jaws is still required. Benham (1942, p. 267) has referred isolated more strongly sculptured teeth from the Middle Oligocene of New Zealand to a species *Squalodon andrewi.* This material requires further investigation.

4. FIRST RECORD OF A CETOTHERIID WHALE FROM AUSTRALIA

In 1885 R. Tate, in a paper on the geology of the Murray River Basin, under the heading "Species of the Lower Murravian," stated:

"This series is characterized rather by lithological than palaeontological characters, which latter are somewhat negative, as the species are few in number

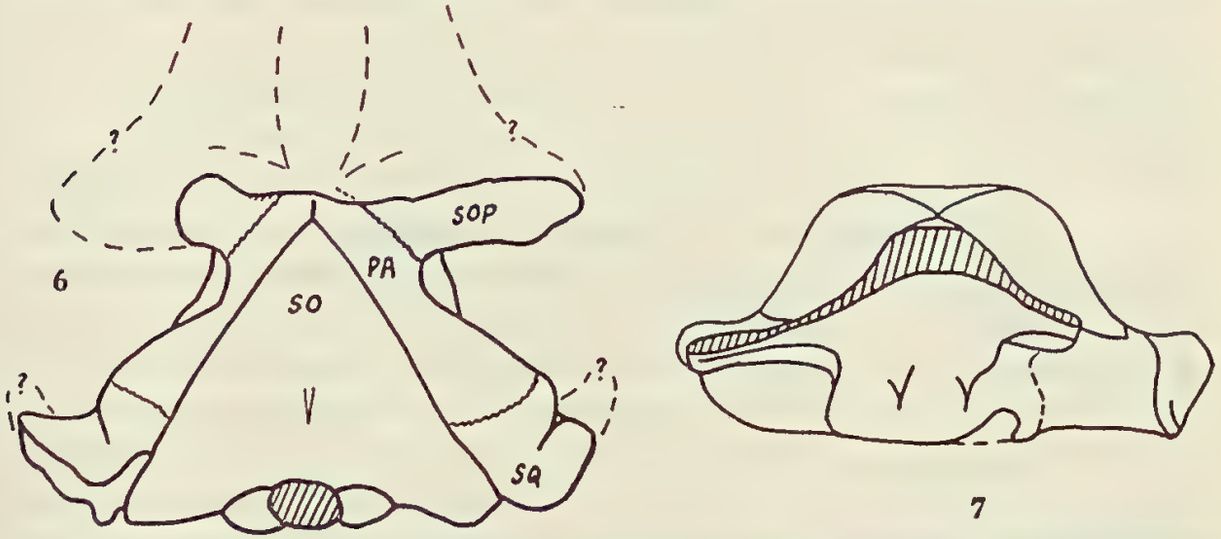

Fig. 6, 7. *Aglaocetus?* sp. nov. 6. Diagrammatic dorsal view of cranium. SO—supraoccipital shield, PA—parietals, SOP—supraorbital process of frontal, SQ—squamosum. About 1/9 nat. size. 7. Diagrammatic frontal view of broken cranium, showing slope of supraorbital processes.

and somewhat sparsely distributed. Cetacean remains have occurred to me only at this horizon, notably at MacBean's Pound, four miles from Blanchetown, whence I obtained the entire lower jaw of a balenoid whale, six feet long, and at Murbko, 14 miles north of Blanchetown, whence I obtained a cranium. The anterior half of a Paguroid (*sic*) fish in excellent preservation was obtained at Morgan from these beds." (Tate, 1885, p. 41.)

Since that time there seems to have been no further reference to the whale cranium from Murbko. Enquiries have now resulted in the re-discovery of this skull in the collections of the South Australian Museum (No. P63). Incidentally, Tate's pagroid fish was found in the collections of the Adelaide University Geology Department (No. F15110) and is now being described by Mr. T. Scott. The beds termed "Lower Murravian" by Tate are currently placed in the Lower Miocene.

The posterior portion of the skull is well preserved and entirely undistorted (fig. 6, 7). It is 480 mm. wide between the broken ends of the zygomatic processes and over 300 mm. long from the occipital condyli to the broken anterior edges of the supraorbital processes. Its maximum height is about 240 mm. and the distance from the upper margin of the foramen magnum to the apex of the supraoccipital shield is 213 mm. The frontorostral portion is missing, but an undistorted transverse section (fig. 7) near the orbital plane is exposed on the broken face of the specimen. The palatal surface was well preserved and has been freed from the matrix by a previous investigator. The skull is filled with yellowish limestone matrix in which small fossils occur.

This skull, which was discovered by Tate more than 70 years ago, is the first member of the family Cetotheriidae, a group of ancestral whalebone whales, from Australia. Kellogg (1928, p. 185) described the main characters of this family as follows:

" . . . we find that the skulls of all known edentulous Miocene cetotheres have supraorbital processes that slope gradually outward from the dorsal surface of the interorbital region to the rim of the orbit and are never abruptly depressed basally below the level of the former as in the balaenopterine whales. Many of these cetotheres retained a well defined intertemporal region, constituted entirely by the parietals, which meet along the median line in front of the supraoccipital shield. In most species the braincase is short and broad, but the supraoccipital shield is quite variable in shape and extent, depending in part upon the degree of forward overthrust."

Kellogg goes on to discuss the relative position of the maxillaries to the frontals and the relations between rostrum and braincase generally. The relevant portion of the skull is not preserved in the present specimen.

More recently, the same author (Kellogg, 1940, pp. 3-4) confirmed his diagnosis of the Cetotheriidae: "The extinct whalebone whales belonging to the family Cetotheriidae were the precursors of the Recent Mysticeti. These cetaceans differ from one another in the extent of the forward overthrust of the supraoccipital shield and in the degree of interdigitation of the posterior ends of the rostral bones with the interorbital region. Skulls of all Recent whalebone whales

differ from those of the archaic less highly modified cetotheres in one very important detail, namely, the abrupt depression of the basal portions of the supraorbital processes below the median interorbital portions of the frontals. On all these cetothere skulls the supraorbital processes slope gradually downward and outward from the level of the dorsal surface of the interorbital region. Thus these cetothere skulls are particularly distinguished from all Recent whalebone whale skulls by the fact that the proximal portions of their supraorbital processes have not as yet been abruptly depressed below the level of the median interorbital elevation of the frontals."

Kellogg has also described a number of new genera (*Mixocetus, Cophocetus, Aglaocetus* Kellogg, 1934) of which the last named, from the Lower Miocene (?) Patagonian Formation, is nearest to the South Australian specimen. This shows in dorsal view a very large triangular supraoccipital shield without a distinct median crest. Its apex reaches forward to just beyond the level of the posterior margins of the supraorbital processes of the frontal. The parietals form a short sharp sagittal crest in front of the apex and separate it from the rostral elements. Differences in the posterior and palatal aspects of the skull and deficiencies in its preservation, particularly of the terminations of the zygomatic processes, make it difficult to decide, without further detailed study and comparison, whether the South Australian specimen can be placed in the South American genus or in one of the other closely related genera, but the characters mentioned above and illustrated in fig. 6 and 7 justify the inclusion of this fossil in the family Cetotheriidae under the provisional designation of *Aglaocetus ? nov. sp.*

It is of considerable interest that Kellogg (quoted by Benham, 1942, pp. 261, 263) had considered the fragmentary skulls from the Upper Oligocene of New Zealand, described by Benham first (1937) as *Lophocephalus* (*nom. preocc.*) and later (1942) as *Mauicetus parki,* as similar to *Aglaocetus.* The arguments given by Benham against this view do not seem to carry much weight. These and other New Zealand cetacean remains need careful re-preparation, re-examination, and comparison with Australian and other material which is likely to yield important results in the fields of phylogeny and biostratigraphy.

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EXPLANATION OF PLATES

PLATE XXXIV

Fig. 1a, b. *Aturia stansburiensis* Glaessner. Holotype. 5/6 nat. size.

Fig. 2. *Aturia clarkei attenuata* Teichert and Cotton. S.A.M. Spec. No. 7153. 5/6 nat. size.

PLATE XXXV

Fig. 1a, b. *Aturia australis* McCoy. A.U.G.D. Spec. No. F15097. Nat. size.

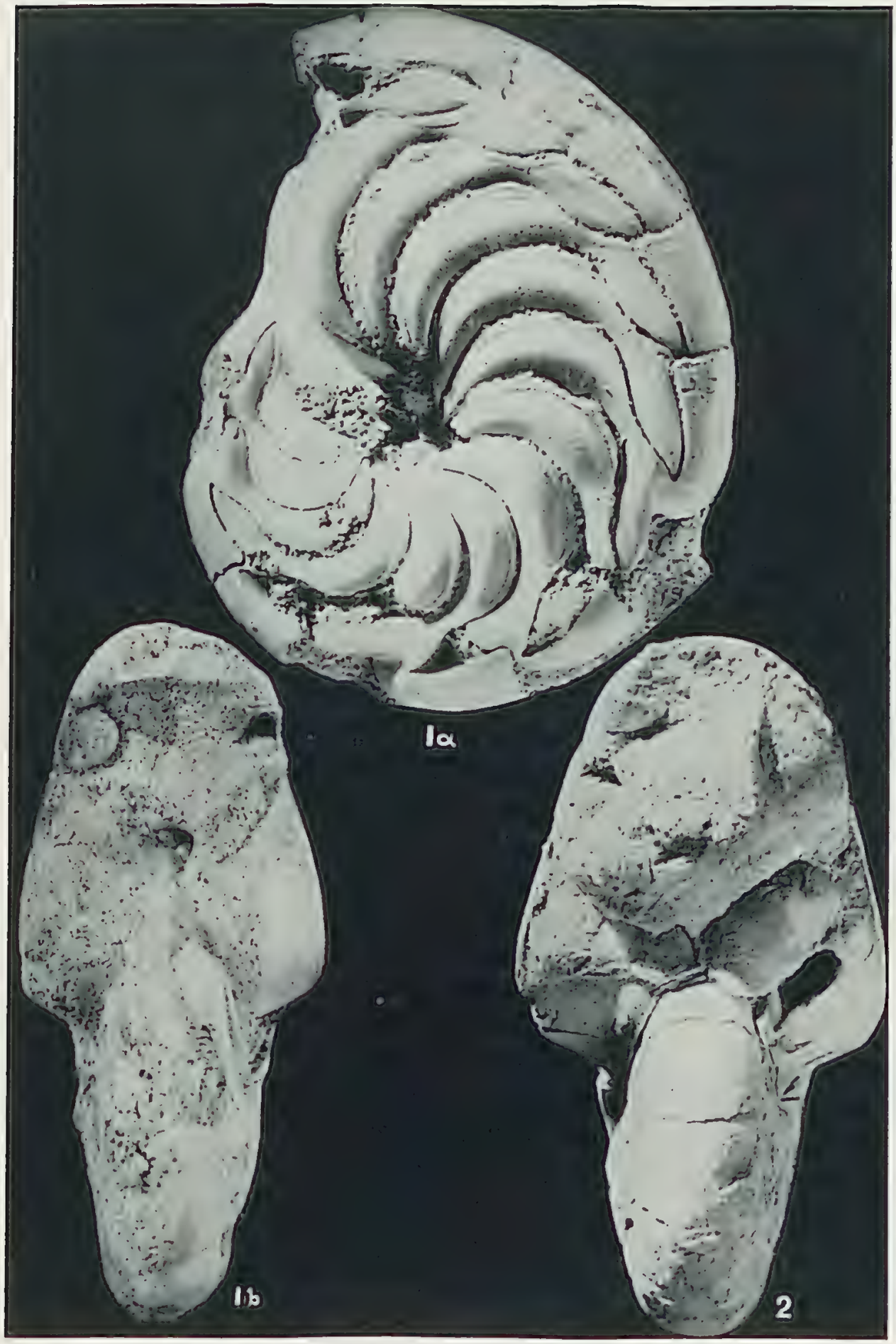
Fig. 2. *Aturia australis* McCoy. Topotype. A.U.G.D. Spec. No. F15108. Nat. size.

Fig. 3. *Aturia clarkei attenuata* Teichert and Cotton. S.A.M. Spec. No. F5219. Nat. size.

PLATE XXXVI

Fig. 1a, b. Humerus of penguin showing bite marks diagonally across the shaft. Note that the lower end (fig. 1a) was cut off with a saw which also left marks at a steeper angle than the matrix-infilled bite marks. Mt. Gambier. S.A.M. Spec. No. P10863. Nat. size.

Fig. 2. Femur of penguin, as extracted from the matrix, showing the proximal end fractured, probably by a bite. S.A.M. Spec. No. P10873. About ×2.


1a
1b
2

1b
1a
3
2

1a
1b
2

PRELIMINARY[1] ACCOUNT OF THE REPTILIA AND AMPHIBIA COLLECTED BY THE NATIONAL GEOGRAPHIC SOCIETY-COMMONWEALTH GOVERNMENT-SMITHSONIAN INSTITUTION EXPEDITION TO ARNHEM LAND (April to November, 1948)

By FRANCIS J. MITCHELL, South Australian Museum

Plate xxxvii and text fig. 1-7

Under the field curatorship of the ichthyologist, Dr. R. R. Miller, the expedition made an official collection of 729 specimens. These have been divided between the United States National Museum, Washington, and the South Australian Museum, Adelaide, as indicated by the abbreviations U.S.N.M. and S.A.M. R. respectively, which precede the reference numbers entered herein. All holotype specimens have been deposited in the latter institution. In addition, a series of 179 specimens comprising the bulk of a collection obtained by the expedition transport officer, Mr. J. E. Bray, and presented to the Australian Museum, Sydney, has also been made available for inclusion in this report. Such specimens are indicated by the abbreviation A.M. R. In all, 908 specimens representing 65 species and subspecies.

The present study was undertaken at the South Australian Museum and extensive use was made of its research collection for purposes of reference and comparison.

The titles of various Australian political areas have been abbreviated as follows: N.T., for Northern Territory; Qld., for Queensland; N.S.W., for New South Wales; Vict., for Victoria; S. Aust., for South Australia; and W. Aust., for Western Australia.

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I wish to acknowledge the co-operation of Dr. Remington Kellogg and Dr. Doris M. Cochran, of the United States National Museum, Washington, and Dr. A. B. Walkom and Mr. J. R. Kinghorn, of the Australian Museum, Sydney, in facilitating my examination of the total reptile and amphibian collection. Their assistance is much appreciated. I am also indebted to Mr. Arthur Loveridge, Museum of Comparative Zoology, Harvard, Mr. G. Mack, Queensland Museum,

[1]A more detailed account will appear in the official journal of the expedition to be published at a later date.

Brisbane, and Messrs. J. Henry and S. J. Copland, of the Macleay Museum, University of Sydney, who forwarded type and other material housed in their respective institutions for my examination.

TESTUDINATA

FAMILY CHELONIIDAE

ERETMOCHELYS IMBRICATA (Linnaeus)

Testudo imbricata Linnaeus, 1766, p. 350.
Eretmochelys squamata Agassiz, 1857, p. 382.

U.S.N.M. 128527, Black Rock Point, Coberg Peninsula, N.T.

LORICATA

FAMILY CROCODYLIDAE

CROCODYLUS POROSUS Schneider

Crocodylus porosus Schneider, 1801, p. 169.

U.S.N.M. 128526, Black Rock Point, Coberg Peninsula, N.T.

U.S.N.M. 128685, South end of Melville Bay, west of Yirrkalla, N.T.

SERPENTES

FAMILY BOIDAE

LIASIS CHILDRENI CHILDRENI Gray

Liasis childreni Gray, 1842, p. 44.

U.S.N.M. 128469, Port Langdon, N.T.

LIASIS FUSCUS FUSCUS Peters

Liasis fuscus Peters, 1873, p. 607.

U.S.N.M. 128768, Oenpelli, N.T.

MORELIA SPILOTES VARIEGATA Gray

Morelia variegata Gray, 1842, p. 43.

U.S.N.M. 128235 (head only), Lee Point, 9 miles north-east of Darwin, N.T.

U.S.N.M. 128442, near Umba Kumba, Groote Eylandt, N.T.

As indicated by Loveridge (1934, p. 270), present data does not suggest any correlation between the distribution of the *variegata* colour phase and a particular geographical region or environment. However, no one worker has yet had the opportunity of examining a large Australia-wide series of this species, and as pure populations of both phases undoubtedly occur, *variegata* is herein retained. [See also Mitchell (1951, p. 545).]

FAMILY COLUBRIDAE

ACHROCHORDUS JAVANICUS Hornstedt

Achrochordus javanicus Hornstedt, 1787, p. 307, pl. xii.

U.S.N.M. 128765-128767, Oenpelli, N.T.

S.A.M. R.2844 (2 specimens), Oenpelli, N.T.

ACHROCHORDUS GRANULATUS GRANULATUS (Schneider).

Hydras granulatus Schneider, 1799, p. 243.

U.S.N.M. 128511, Milimgimbi Island, N.T.

FORDONIA LEUCOBALIA (Schlegel)

Homalopsis leucobalia Schlegel 1837, p. 345, pl. xiii, fig. 8-9.

U.S.N.M. 128334, Inlet at dock for Delisseville, 11 miles west-south-west of Darwin, N.T.

ENHYDRIS POLYLEPIS (Fischer)

Hypsirhina polylepis Fischer, 1886, p. 14.

U.S.N.M. 128474, Port Langdon, N.T.

U.S.N.M. 128450, near Umba Kumba, Groote Eylandt, N.T.

Kinghorn (1929, p. 90) appears to be in error when he records single subcaudals for *macleayi* Ogilby, a species which Loveridge (1934, p. 273) places in the synonymy of *polylepis*.

AHAETULLA PUNCTULATA PUNCTULATA (Gray)

Leptophis punctulatus Gray, 1827, p. 432.

U.S.N.M. 128445-128447, near Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128769-128771, S.A.M. R.2845, Oenpelli, N.T.

U.S.N.M. 128683-128684, Yirrkalla, N.T.

U.S.N.M. 128470-128472, Port Langdon, N.T.

U.S.N.M. 128233, West Point, 5 miles west of Darwin, N.T.

The longitudinal dark line under the tail, stated to be characteristic of the New Guinea race *lineolata* (Guichenot) is present in about half of this series, being particularly prominent in the three specimens from Groote Eylandt. As recorded by Loveridge (1948, p. 385) the horizontal diameter of the eye relative to the other head dimensions varies considerably with age in this species.

NATRIX MAIRII MAIRII (Gray).

Tropidonotus mairii Gray, 1841, p. 442.

U.S.N.M. 128443-128444, near Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128772, Oenpelli, N.T.

CERBERUS RHYNCHOPS AUSTRALIS (Gray)

Homalopsis australis Gray, 1842, p. 65.

U.S.N.M. 128264, Nightcliff, near Darwin, N.T.

A single South Australian Museum specimen from Melville Island, N.T., was also examined.

Ventral scales 146, 148; subcaudals in 48 (tail incomplete) and 56 pairs; anal divided; 23 and 25 rows of keeled scales at midbody. A suture through the nostril to the first labial on one side of the head and to the second labial on the other in both specimens; loreal contacting the 1st, 2nd, 3rd and 4th, or 2nd, 3rd and 4th upper labials. A single preocular scale extends around to a point well under the eye; one or two sub- and two post-oculars.

The designation of these two specimens to *australis* is based mainly on the locality, it being evident from the above data that they do not conform satisfactorily to any of the three subspecies as keyed by Loveridge (1948, p. 389), his key being based on a series of 70 *r. rhynchops*, 5 *r. novaeguinea*, 4 *r. australis* and presumably data published by Boulenger (1896, 1897) and De Rooij (1917).

If the tails were complete, both specimens would possess more than Loveridge's maximum of 51 pairs of subcaudals and would be identifiable as *r. rhynchops*. On the other hand, if the diagnosis is based on the nasal cleft, there would be equal grounds for placing these specimens with either *novaeguinea* or *australis*. It is possible that the circumocular scalation will be found to provide a better keying character for the separation of the three subspecies. In figuring *australis* Boulenger shows the nasal cleft joining the 2nd upper labial on one side and the preocular on the other, with only the second and third upper labials contacting the loreal, the fourth being widely separated from it. De Rooij (1917, fig. 70) figures *rhynchops* and shows a smaller preocular and two suboculars.

Although it seems probable that *australis* and *novaeguinea* can be satisfactorily distinguished from the type race, many more specimens will have to be examined and their variation tabled before a practicable key can be devised.

BOIGA FUSCA (Gray)

Dendrophis fusca Gray, 1842, p. 54.

U.S.N.M. 128473, Port Langdon, N.T.

FAMILY ELAPIDAE

ASPIDOMORPHUS DIADEMA (Schlegel)

Calamaria diadema Schlegel, 1837, p. 32.

U.S.N.M. 128261, Nightcliff, 7 miles north-east of Darwin, N.T.

Midbody scales in 15 rows; 176 ventrals; 54 pairs of subcaudals; anal divided.

Preocular almost separating the supraocular from the prefrontal. Nostril breaking the upper edge of the nasal shield.

The patterning of this specimen very closely resembles that of *christieanus* Fry, with which this species coexists in the vicinity of Darwin. The head and neck are black with a broad lighter band across the nape replacing the more usual small crescent shaped marking. Upper labials and ventral surfaces white; dorsal surfaces pale yellow, each scale being edged with brown, giving a network effect.

ASPIDOMORPHUS CHRISTIEANUS (Fry)

Pseudelaps christieanus Fry, 1915, p. 91, fig. 6.

U.S.N.M. 128262, Nightcliff, 7 miles north-east of Darwin, N.T.

Midbody scales in 17 rows; 187 ventrals; 49 pairs of subcaudals; anal divided. The nasal is widely separated from the preocular which joins the frontal.

An additional specimen from Nightcliff was presented to the South Australian Museum in 1949 and a note forwarded with it suggests that the species is quite common within a limited distribution centred near Darwin. It is registered S.A.M. R.2995, and possesses 17 midbody scales; 185 ventrals; 43 pairs of subcaudals and a divided anal. It is the larger of the two and measures 375 (319+56) mm.

The tails of both of these specimens appear to be complete, indicating that the subcaudal count is variable. It has been recorded as 38 (type specimen), 49 and 43 (the present specimens), 56 (Loveridge, 1934, p. 276) and 57 (Longman, 1916, p. 48).

The general ground colour is almost white tending yellow middorsally; each scale is edged with purple, giving the dorsal surface a reticulate appearance. A light band across the nape separates a dark purple neck band from the still darker head.

The distributions of *diadema and christieanus* appear to meet in the vicinity of Darwin, and the close superficial resemblance of the two snakes in this district, together with the geographical segregation of *christieanus* in suitable districts of north-western Australia, suggests that it may only be a subspecies of *diadema,* distinguishable by its greater midbody count and several minor differences in colouration. Both snakes display a wide variation in ventral and subcaudal scale counts.

DEMANSIA CARINATA (Longman)

Diemenia carinata Longman, 1915, p. 31, fig.

U.S.N.M. 128471, Port Langdon, N.T.

The record of this specimen from Port Langdon is interesting as it considerably extends the known range of this arboreal *Demansia,* the type locality being Cane Grass Station, via Charlesville, in western Queensland.

DEMANSIA PSAMMOPHIS PSAMMOPHIS (Schlegel)

Elaps psammophis Schlegel, 1837, p. 455.

U.S.N.M. 128448, near Umba Kumba, Groote Eylandt, N.T.
U.S.N.M. 128263, Nightcliff, near Darwin, N.T.

PSEUDECHIS AUSTRALIS (Gray)

Naja australis Gray, 1842, p. 55.

U.S.N.M. 128451, S.A.M. R.2843 (2 specimens), near Umba Kumba, Groote Eylandt, N.T.

OXYURANUS SCUTELLATUS (Peters)

Pseudechis scutellatus Peters, 1867, p. 710.
Oxyuranus maclennani Kinghorn, 1923, pp. 42-45.

U.S.N.M. 128773 (head and neck only), 20 miles N.E. of Oenpelli, N.T.

ACANTHOPHIS ANTARCTICUS ANTARCTICUS (Shaw)

Boa antarctica Shaw, 1894, pl. mxxxv.

U.S.N.M. 128476-128477, S.A.M. R.3226, Port Langdon, N.T.

Head shields multikeeled, one specimen approaching the *palpebrosa* condition. General colouration typical of the species, these specimens possessing a smooth scaled, strongly compressed, white extremity to the tail.

A comparison of this Arnhem Land material together with other northern Australian specimens with southern Australian examples indicates that the colour variation of the caudal extremity is largely, if not completely, correlated with locality. Also, there would appear to be some variation in its form, southern specimens possessing an acutely keeled extremity with strongly imbricate scales. (See fig. 1.)

South Australian Museum specimens from the following localities were examined. Those possessing a light coloured caudal extremity were from Bathurst Head, Qld. (2 specimens); Coen River, Qld. (1 specimen); Melville Island, N.T. (1 specimen); Roper River, N.T. (1 specimen).

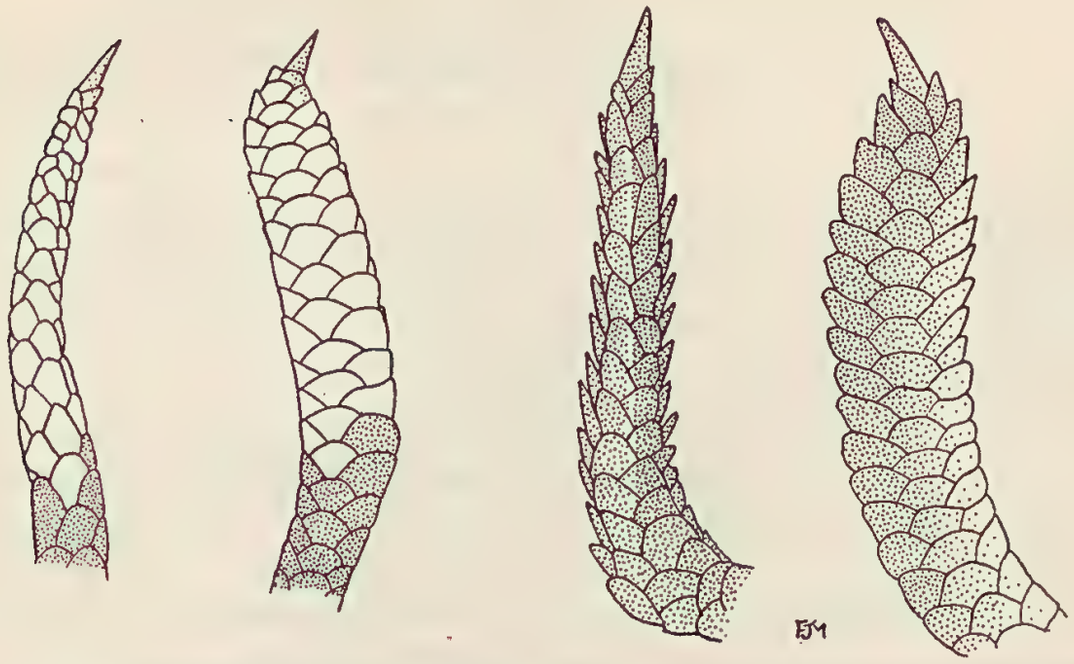

Fig. 1. *Acanthophis antarcticus* (Shaw): dorsal and lateral views of the caudal appendage, showing the variation in colour and form (see text).

Those possessing a dark coloured caudal extremity were from Penong, S. Aust. (1 specimen); Reevesby Island, S. Aust. (1 specimen); Koonibba, S. Aust. (2 specimens); Ardrossan, S. Aust. (6 specimens); 20 miles west of Whyalla, S. Aust. (1 specimen); Hallett's Cove, S. Aust. (1 specimen); Denial Bay, S. Aust. (1 specimen); Coorabie (near Fowlers Bay), S. Aust. (1 specimen); and 7 specimens taken at local beaches near Adelaide, S. Aust.

Although I have been unable to find any other character correlated with this caudal variation, its constancy within the material examined and apparent geographic segregation indicate that it is more than an irregular variant, and the possibility of the two groups being sub-specifically distinct is worthy of further consideration. In dealing with Indo-Australian specimens, De Rooij (1917, p. 273) states "end of tail yellow or black." Whether this statement is based on the Indo-Australian material examined or merely following Boulenger (1896, p. 355) is not clear. The specimen figured by De Rooij (*op. cit.* fig. 111) has a light caudal extremity.

FAMILY HYDROPHIIDAE

HYDROPHIS ELEGANS (Gray)

Aturia elegans Gray, 1842, p. 61.

U.S.N.M. 128473, Port Langdon, N.T.

SAURIA

FAMILY GEKKONIDAE

HETERONOTA BINOEI Gray

Heteronota binoei Gray, 1845, p. 174.

U.S.N.M. 128539-128556, S.A.M. R.2854 (28 specimens), Yirrkalla, N.T.

U.S.N.M. 128282-128291, 128463, A.M. R.12473 (3 specimens), R.13474 (3 specimens), Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128240-128246, Nightcliff, near Darwin, N.T.

U.S.N.M. 128518, Rocky Beach, Cape Arnhem, N.T.

U.S.N.M. 128525, Black Rock Point, Coberg Peninsula, N.T.

A.M. R.12651 (7 specimens), Cape Arnhem, N.T.

HEMIDACTYLUS FRENATUS Dumeril and Bibron

Hemidactylus frenatus (Schleg.) Dumeril and Bibron, 1836, p. 366.

U.S.N.M. 128494, S.A.M. R.2872 (2 specimens), Milimgimbi Island, Crocodile Islands, N.T.

OEDURA RHOMBIFERA Gray

Oedura rhombifera Gray, 1844, pl. xvi, fig. 6.

U.S.N.M. 128531-128534, S.A.M. R.2859 (3 specimens), Yirrkalla, N.T.

U.S.N.M. 128460-128461, Central Hill, Groote Eylandt, N.T.

U.S.N.M. 128293-128299, A.M. R.12627 (5 specimens), R.13518 (2 specimens), R.13517 (2 specimens), Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128728, Oenpelli, N.T.

U.S.N.M. 128516-128517, Birlouja Creek, N.T.

A.M. R.13559 (2 specimens), Cape Arnhem, N.T.

S.A.M. R.2870 (3 specimens), Gove Air Base, 8 miles south-west of Yirrkalla, N.T.

OEDURA MARMORATA Gray

Oedura marmorata Gray, 1842, p. 52.

U.S.N.M. 128557-128565, S.A.M. R.2864, Yirrkalla, N.T.

U.S.N.M. 128729, Oenpelli, N.T.

U.S.N.M. 128515, Purlonkoima Creek, N.T.

A.M. R.13551-13553, Cape Arnhem, N.T.

DIPLODACTYLUS STROPHURUS CILIARIS Boulenger

Diplodactylus ciliaris Boulenger, 1885, p. 98, pl. viii, fig. 2.

U.S.N.M. 128247, Nightcliff, near Darwin, N.T.

This specimen is almost topotypic.

Brazenor (1951) and Glauert (1952) have contributed much toward clarifying the taxonomy of this species and associated forms by examining the specimens preserved in the National Museum, Melbourne, and the Western Australian Museum, Perth, respectively. In an endeavour to link the work of these two authors, the collection in the South Australian Museum, Adelaide, has been examined and a general zoogeographical study undertaken.

This has resulted in *strophurus* being considered a polytypic species in which the subspecies *spinigerus, ciliaris* and *aberrans* can be satisfactorily distinguished from the type race. The subspecies *intermedius* Ogilby is provisionally recognized, but additional work on its variation will have to be undertaken before its status can be satisfactorily determined.

An analysis of the variation of the individual characters has revealed several distinct geographical trends. The supraciliary spines are well developed in the northern populations, reduced to short conical tubercles in Central Australian specimens, and ill-defined or absent in material collected in the south-western and south-eastern corners of the continent. A survey of the literature and the specimens examined reveals all stages in this north to south gradation, and the inconsistency of this, and other characters in the *intermedius* zone which separates the typical populations of *ciliaris* and *strophurus* has resulted in two or more of the races being recorded from the one locality. An example is two specimens in the South Australian Museum collection taken at Well 32 on the Canning Stock Route in Western Australia. One of these had been identified as *ciliaris* and the other as *intermedius*. Both of these specimens have the supraciliary and caudal spines reduced to short conical tubercles, but whereas the lineal distribution of the dorsal tubercles persists in one specimen, there is little sign of regularity in the other. Similarly, a collection of seventeen specimens collected from between the Everard and Musgrave Ranges, South Australia, contains these two variants, and other specimens showing additional intermediary stages. Kinghorn (1929, pp. 80-81) identified three forms from New South Wales, *intermedius* with regularly distributed dorsal tubercles, *strophurus* with scattered dorsal tubercles, and some specimens from the northern half of the State which he identified as *spinigerus*. From the variation noted among some collections taken further west, and the reference by Longman (1916, p. 50) to some southern Queensland specimens possessing short supraciliary spines, it is sug-

gested that the latter specimens strictly belong to the subspecies *ciliaris,* although the reduction of the supraciliary spines, without a corresponding decrease in the size of the caudal spines made *spinigerus* the only practicable identification at that time.

An examination of several Western Australian specimens, together with the data provided by Glauert (*op. cit.*) indicate a similar gradation of characters between *strophurus* and *spinigerus.* Typical specimens of *spinigerus* appear to be restricted to within the Mulga-Eucalypt line in the south-west, and although some specimens taken to the north-east can be identified as *spinigerus,* they show definite signs of gradation toward *strophurus.* Specimens examined from Laverton, Malcolm and Frazer Range, Western Australia, possess reduced caudal spines and distinct supraciliary tubercles. Glauert (*op. cit.*) mentions that some south-western specimens possess solid tubercles along the supraciliary border and also records an additional specimen from Laverton, W. Aust., with the caudal spines reduced to tubercles.

The describing of the subspecies *aberrans* has provided an additional link between *strophurus* and *ciliaris* as it indicates how the transverse rows of caudal tubercles in *strophurus* and *intermedius* could have evolved. Each ring of tubercles comprises four of approximately equal size on the dorsal surface. Two of these replace the spines, and an additional pair have formed between them. In *aberrans,* the central pair of tubercles have formed without any depreciation in the size of the caudal spines.

From the present study only one feature appears to be sufficiently stable to provide a foundation for separating *intermedius* from *strophurus,* and this is the regularity of the dorsal tubercle distribution. The disposition of the caudal tubercles appears to be identical in both forms although the segmentation is not as pronounced in the eastern form. If specimens of the *strophurus* type, but with the dorsal tubercles distributed uniformly in two longitudinal series are accepted as representing *intermedius,* then the race can be recorded as occurring from northern Victoria, south-eastern South Australia to central New South Wales and extending across a narrow zone in northern South Australia into Western Australia. Although this distribution pattern is rather unusual and one is hesitant to accept a race based on a single definable, but rather unstable difference, the large area over which recognizable specimens have been taken make its provisional recognition appear warranted. Ogilby's name for this race is most appropriate as it appears to cover a discontinuous series of populations, in which several of the major features are at median stages of distinct geographical trends.

A synopsis of the salient features and recorded distributions of the subspecies is as follows:

Diplodactylus strophurus strophurus (Dumeril and Bibron).

Supraciliary spines replaced by short conical tubercles; dorsal surface of the body with irregularly distributed tubercles. Tail with sixteen or seventeen rings of enlarged tubercles, each ring representing the position of one pair of caudal spines in other races, and composed of four major tubercles of approximately equal size on the dorsal surface.

Recorded distribution: Type locality, Shark's Bay, W. Aust.; Mount Narryer Station, W. Aust.; Murchison District, W. Aust.; Yalgoo District, W. Aust.; Carnarvon, W. Aust.; Milly Milly Station, W. Aust. (Glauert, 1952). Wells 32, 39 Canning Stock Route, W. Aust.; Barrow Ranges, W. Aust.; Ooldea, S. Aust.; between Everard and Musgrave Ranges, S. Aust. (South Australian Museum). Hillston, N.S. Wales; Leeton, N.S. Wales (Kinghorn, 1929).

Diplodactylus strophurus intermedius Ogilby.

General form and scalation similar to that of the type race, but possessing the dorsal tubercles uniformly distributed in two longitudinal series. Segmentation not obvious in regenerated tails although the tubercles are occasionally reproduced.

Recorded distribution: Type locality, "Interior of New South Wales." Northern Mallee districts of Victoria; Purnong, S. Aust. (Brazenor, 1951). Tintinara, S. Aust.; Peake, S. Aust.; Wilpena Pound, S. Aust.; between the Everard and Musgrave Ranges, S. Aust.; Well 32, Canning Stock Route, W. Aust. (South Australian Museum). Bogagabri, N.S. Wales; Lachlan River, N.S. Wales; Carinda, N.S. Wales (Kinghorn, 1929). Darling Downs, Qld. (Longman, 1916).

Diplodactylus strophurus ciliaris (Boulenger).

Supraciliary and caudal spines fully developed; dorsal tubercles distributed uniformly in two longitudinal series.

Recorded distribution: Type locality, Darwin, N.T.; Dunraven, Qld.; Prairie, Qld.; Army Downs, Qld. (Loveridge, 1934). Sylvania, Qld. (Kinghorn, 1929). Yuendumu, N.T.; Tempe Downs, N.T.; junction of Fitzroy and Margaret Rivers, W. Aust.; Well 39, Canning Stock Route, W. Aust.; Erldunda, N.T.; Tennant Creek, N.T.; Hermannsburg Mission, N.T. (South Australian Museum). Murchison District, W. Aust.; Mount Margaret, W.

Aust.; Yandie Station, Canning Stock Route, W. Aust. (Glauert, 1952). Specimens recorded by Kinghorn (1929) from Tamworth, Lachlan River, Yandembah, Barmedonan, Coonamble, Wyalong, Hillston in New South Wales and Bowen in Queensland and identified as *spinigerus* are probably referable to this race.

Diplodactylus strophurus aberrans Glauert.

Supraciliary and caudal spines fully developed, the supraciliary spines extending on to the nape in the form of short tubercles. Two enlarged tubercles between each pair of caudal spines.

Recorded distribution: Type locality, Mt. Wynna, West Kimberley, W. Aust.; La Grange, W. Aust.; Wallal, W. Aust.; King Sound, W. Aust. (an Australian Museum specimen recorded by Kinghorn (1929) as *ciliaris*). 100 miles east of 80-mile Beach, W. Aust. (South Australian Museum).

Diplodactylus strophurus spinigerus (Gray).

Supraciliary spines absent; caudal spines well developed. Tubercles on the dorsal surface of the body slightly irregular but forming two distinct longitudinal series.

Recorded distribution: Type locality, Houtman Abrolhos, W. Aust.; Cunderdin, W. Aust.; Kulin, W. Aust.; Mount Magnet, W. Aust.; Perth, W. Aust. (Loveridge, 1934); Frazer Range, W. Aust. (South Australian Museum).

GEHYRA VARIEGATA AUSTRALIS Gray

Gehyra australis Gray, 1845, p. 163.

U.S.N.M. 128292, 128300, Umba Kumba, Groote Eylandt, N.T.
U.S.N.M. 128535-128538, S.A.M. R.2861, Yirrkalla, N.T.
A.M. R.13638 (2 specimens), East Alligator River, N.T.
A.M. R.13556, Cape Arnhem, N.T.
S.A.M. R.2863, Oenpelli, N.T.
S.A.M. R.2862, Milimgimbi Island, Crocodile Islands, N.T.

Subdigital scansors undivided anteriorly but with a median groove posteriorly; a slight rudiment of a claw is evident on the fifth toe in several specimens and the rudiment of a web at the base of the toe seems to be more prominent than in *variegata variegata*. A cutaneous fold present along the back of the thigh; in three specimens a dorsal-lateral fold is also present, but this may be the result of dehydration by strong preservative. Nine to eleven

enlarged upper, and seven to nine enlarged lower labials. Two or three postnasals; internasals forming a medium suture or separated by one or two small granules. Five of this series are males and they possess 15-29 (average 22) preanal pores.

Contrary to the findings in other species, the Arnhem Land specimens of this species seem to possess a greater average number of preanal pores than specimens taken further south. Loveridge (1934, p. 313) records an average of 15 with range of 13-19 for five Queensland males, while an examination of the males in the South Australian Museum collection gave the following data. *G.v. australis,* six males possessing 13-21, average 16; *G.v. punctata,* four males possessing 11-13, average 12 (Loveridge (*op. cit.*) also records 11-13 for *punctata*); *G.v. variegata,* thirty-three males possessing 9-21, average 15.

The colour varies from uniform light blue to light brown with indistinct darker variegations. When analysed under a microscope, the light blue colour is shown to be a translucent white minutely punctate with black.

The position and status of *punctata* Fry have been verified by the examination of eleven specimens in the South Australian Museum collection. The best diagnostic feature for its separation appears to be the shape of the mental and chinshields (see fig. 2), the characters used by Fry in his type description being both variable and difficult to define.

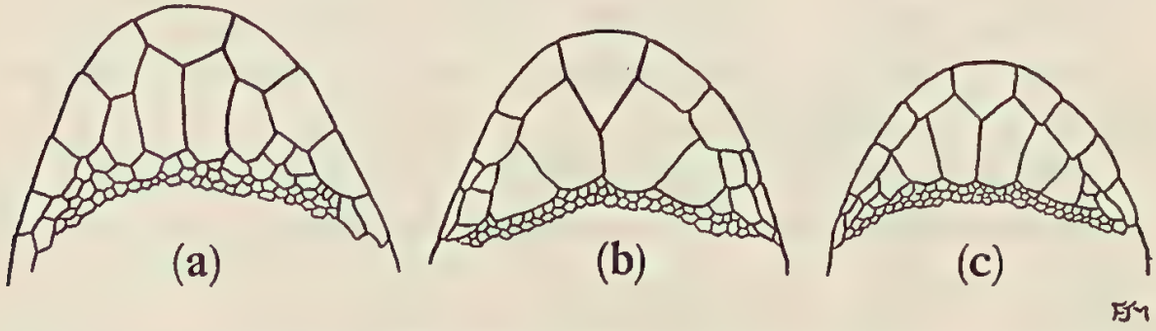

Fig. 2. *Gehyra variegata* (Dumeril and Bibron): ventral view of the snout of (a) *G. v. australis* Gray; (b) *G. v. punctata* (Fry) and (c) *G. v. variegata* (Dumeril and Bibron).

On examining the type description of *variegata* (Dumeril and Bibron, 1836, p. 353), it was noted that one of the four type specimens is referable to *punctata,* being from "baie de Chiens Marins" or Shark Bay, Western Australia. The remaining three specimens, which are mentioned first wherever the variation warrants a comparison and are therefore accepted as representing the type race, were reputedly taken in Tasmania ("la terre de Vandieman"). The species has not been subsequently recorded as occurring on the island and the last

person to list the lizards of Tasmania, Hewer (1948), completely omits the species.

The South Australian Museum specimens are from the following localities:

Gehyra variegata variegata: South Australia.—Ooldea, 3 specimens; northern Flinders Ranges, 22 specimens; Mount Lofty Ranges, 8 specimens; Lake Phillipson, south-west of Stuart Range, 1 specimen; Quorn, 1 specimen; Koonibba, 1 specimen; Streaky Bay, 1 specimen; Devon Downs, 1 specimen; Puttaburra, via Marree, 1 specimen; Gawler Ranges, 2 specimens; Mt. Painter, 1 specimen; Lake Callabonna, 21 specimens; between Everard and Barrow Ranges, 2 specimens; Fowlers Bay, 1 specimen; Kangaroo Island, 10 specimens; Wynbring, 2 specimens; Encounter Bay, 1 specimen; Sutherlands, 1 specimen; Buckleboo, 2 specimens; Mooloolo, 7 specimens; Tarcoola, 3 specimens; Oodnadatta, 2 specimens; between Everard and Musgrave Ranges, 17 specimens; Finniss Springs, 10 specimens; Warcowie, 2 specimens; Marree, 4 specimens; Andamooka Ranges, 7 specimens; Gammon Ranges, 1 specimen; Strzelecki Creek, 5 specimens; Killalpannina Mission, 4 specimens; Clayton, 2 specimens; Coopers Creek, 3 specimens; Eudunda, 1 specimen.

Northern Territory.—Hermannsburg, 25 specimens; Charlotte Waters, 1 specimen; Cordilla Downs, 2 specimens; Macdonnell Ranges, 23 specimens; Hanns Range, 1 specimen.

New South Wales.—Dareton, 2 specimens.

Western Australia.—Frazer Range, 3 specimens; Broad Arrow, 1 specimen.

Gehyra variegata australis: Northern Territory.—Darwin, 7 specimens; Tennant Creek, 3 specimens.

Queensland.—Bathhurst Head, 5 specimens; Cairns, 1 specimen.

Gehyra variegata punctata: Western Australia.—Gascoyne District, 7 specimens; Flora Valley, East Kimberleys, 1 specimen; Canning Stock Route, 3 specimens.

FAMILY AGAMIDAE

CHLAMYDOSAURUS KINGII Gray

Chlamydosaurus kingii Gray, 1827, p. 425, pl. A.

U.S.N.M. 128480, Milimgimbi Island, Crocodile Islands, N.T.

U.S.N.M. 128452-128453, Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128568, S.A.M. R.3228, Yirrkalla, N.T.

U.S.N.M. 128752, Oenpelli, N.T.

AMPHIBOLURUS CAUDICINCTUS CAUDICINCTUS (Gunther)

Grammatophora caudicincta Gunther, 1844, p. 19.

U.S.N.M. 128751, S.A.M. R.3229, 4½ miles S.S.E. of Oenpelli, N.T.

Loveridge (1934, p. 319) suggests that *rufescens* Stirling and Zietz and *imbricatus* Peters may prove to be races of *caudicinctus* Gunther. Preliminary work on a revision of the genus *Amphibolurus* has been undertaken by the author and the above possibility investigated. The types (S.A.M. R.1423, R.1424 and R.1425) and four other specimens of *rufescens* have been examined and compared with *caudicinctus*. Although they do resemble one another in colour and general form, they differ markedly in structural detail, and until more extensive work on the distribution and variation of these lizards can be undertaken, no advantage is to be gained by linking them under a specific name, although this may ultimately prove warranted. The following characters serve to distinguish the two lizards:

A. caudicinctus Gunther	*A. rufescens* Stirling and Zietz
1. Femoral and preanal pores 29-35.	Femoral and preanal pores 56-60.
2. Canthus rostralis swollen and rounded, with nostril in the rostralis, directed upward.	Canthus rostralis obtuse, but angulate, with nostril below the rostralis, directed outward.
3. A longitudinal series of enlarged middorsal scales and low spinous nuchal crest.	No longitudinal series of enlarged middorsal scales, and a slightly enlarged, non spinous series of midnuchal scales.

After examining eleven specimens from the vicinity of Marree and Finniss Springs, S. Aust., the author is of the opinion that *imbricatus* Peters is specifically distinct from *caudicinctus* Gunther.

AMPHIBOLURUS BARBATUS BARBATUS (Cuvier)

Agama barbatus Cuvier, 1829, p. 35.

U.S.N.M. 128529, Horseshoe Bend, Finke River, S. Aust.

Although most characters of this specimen agree with those of the type race, the "beard" is not developed to the same extent as that of specimens taken further south, showing a tendency toward the sub-species *minor* Sternfeld, which was originally taken at Hermannsburg, N.T. It apparently occurs at that locality and westward, as specimens examined from localities to the south, east and north are all nearer the type race. Loveridge (1934, p. 325) records a specimen of *minor* from the north-west coast at Broome, W. Aust.

DIPORIPHORA BILINEATA Gray

Diporiphora bilineata Gray, 1842, p. 54; Loveridge, 1934, p. 327 (Syn.).

U.S.N.M. 128301, 129542-129561, S.A.M. R.2848 (29 specimens), Umba Kumba, Groote Eylandt, N.T.

A.M. R.13621 (7 specimens), R.13613 (6 specimens), R.13617 (6 specimens), Groote Eylandt, N.T.

U.S.N.M. 128734-128749, S.A.M. R.2847, Oenpelli, N.T.

U.S.N.M. 128248-128249, Nightcliff, near Darwin, N.T.

U.S.N.M. 128455, south end of Lake Hubert, N.T.

A.M. R.13644 (4 specimens), East Alligator River, N.T.

S.A.M. R.2858 (1 specimen), Yirrkalla, N.T.

Preanal pores present in the male, 1+1 or 2+2; gular fold constantly absent. This latter character serves to readily distinguish *bilineata* from *Physignathus gilberti* (Gray), some specimens of which closely resemble it.

PHYSIGNATHUS GILBERTI GILBERTI (Gray)

Lophognathus gilberti Gray, 1842, p. 53.

U.S.N.M. 128730, 128732-128733, S.A.M. R.2941 (3 specimens), Oenpelli, N.T.

U.S.N.M. 128731, 2 miles S.S.E. of Oenpelli, N.T.

U.S.N.M. 128566, Yirrkalla, N.T.

U.S.N.M. 128456, west side of Lake Hubert, N.T.

U.S.N.M. 128454, south end of Lake Hubert, N.T.

U.S.N.M. 128464, between Emerald River and Old Mission, Groote Eylandt, N.T.

A.M. R.13639, East Alligator River, N.T.

FAMILY VARANIDAE

VARANUS (VARANUS) GOULDII (Gray)

Hydrosaurus gouldii Gray, 1838, p. 394.

U.S.N.M. 128571-128573, 128575, Yirrkalla, N.T.

U.S.N.M. 128384, 4 miles south-west of Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128479, Port Langdon, N.T.

U.S.N.M. 128753, Red Lily Lagoon, 7 miles W.S.W. of Oenpelli, N.T.

U.S.N.M. 128754, Oenpelli, N.T.

VARANUS (VARANUS) VARIUS (Shaw)

Lacerta varia Shaw, 1790, p. 246, pl. iii, fig. 2.

U.S.N.M. 128386, near swamp at Lake Hubert, N.T.

S.A.M. R.3230, 5 miles west of Oenpelli, N.T.

VARANUS (ODATRIA) GLEBOPALMA sp. nov.

Holotype: S.A.M. R.3222 an adult male taken at the south end of Lake Hubert, N.T.

Diagnosis: This *Varanus* is a typical member of the *Odatria* group and is most nearly approached by the subspecies *timorensis tristis* (Schlegel). It differs from that lizard in possessing a much longer tail, different colouration and characteristic dorsal and caudal scalations (see pl. xxxvii). The best diagnostic feature is the presence of highly polished black pads on the soles of all four feet. (See fig. 3.)

Description: Teeth acute, slightly compressed. Canthus rostralis acute, nostrils oval, below the rostralis, nearer the tip of the snout than the anterior corner of the eye, the measurements from the centre of the nostril being 9 mm. and 12 mm. respectively. Upper head scales moderate, slightly larger than the temporals but smaller than the interorbitals; 37-40 between the supraciliary ridges. Two or three rows of scales at the supraciliary border larger than the supraoculars. Ear opening triangular, slightly oblique; its vertical diameter is approximately equal to the horizontal diameter of the eye. Dorsal and caudal scales of characteristic forms, not approached by the variation recorded for *timorensis*. (See pl. xxxvii.) Abdominal scales smooth, in one hundred and twenty-six transverse rows. Tail slightly depressed basally, compressed posteriorly; covered with uniform, obtusely keeled scales which do not rise to a spine. The spines often to be found on each side of the vent in males of *Odatria* species are absent, being replaced by several slightly prominent scales. Scales on the limbs with an obtuse central keel. The soles of both fore and hind limbs are covered with highly polished black pads, the largest pads being at the base of each digit. (See fig. 3.) The tail is very long, measuring more than the combined lengths of the head and body.

The basic colour pattern of the body is light grey-brown with numerous black scales distributed irregularly over the dorsal surface. On the anterior half of the tail the black scales become dominant, while toward its tip the basal colouring lightens and black pigmentation disappears. Under side of the lower jaw white with four black transverse bands; remainder of gular region and chest with a black and white recticulate patterning.

Fig. 3. *Varanus glebopalma* Mitchell: view of the sole of the hind foot showing the positions and size of the polished black pads.

Measurements: 821 (262+559) mm.—the distance from the tip of the snout to the gular fold is 112 mm., while 75 mm. and 107 mm. are the lengths of the fore and hind limbs respectively.

Comments: The type specimen is unique and was "shot by R. R. Miller and F. M. Setzler in a crevasse of a sandstone boulder at the base of a sandstone escarpment near south end of Lake Hubert" (R.R.M.).

VARANUS (ODATRIA) TIMORENSIS ORIENTALIS Fry

Varanus punctatus var. *orientalis* Fry, 1913, p. 18.

U.S.N.M. 128481-128485, 128487-128493, S.A.M. R.3227, Milimgimbi Island, Crocodile Islands, N.T.

U.S.N.M. 128569-128570, 138574, Yirrkalla, N.T.

U.S.N.M. 128387, S.A.M. R.2851, Umba Kumba, Groote Eylandt, N.T.

A.M. R.13637, R.13646, East Alligator River, N.T.

A.M. R.12550, Cape Arnhem, N.T.

The following South Australian Museum specimens were also examined: *V.t. orientalis*—R.137, R.182, R.183, Eidsvold, Qld. (type locality); R.351-353, Stewart River, Qld.; R.362-365, Melville Island, N.T.; R.1938, Flinders Island, Qld.

V.t. tristis—R.329, Macdonnell Ranges, N.T.; R.2058, between Mt. Singleton and Treur Range, S. Aust. (4 specimens); R.2186, Kairi, Qld.; R.3085, Frazer

Range, W. Aust.; R.3223, Innamincka, S. Aust.; R.3224, Tennant Creek, N.T. (5 specimens).

The dorsal and caudal scalations of the material listed above show considerable variation. It indicates that the scalation characters enumerated and figured by Fry (1913, pp. 18-19, fig. 7-10) as distinguishing features are inadequate to satisfactorily characterize this subspecies. However, several more easily discernible and constant features distinguishing it from the other subspecies are described by Mertens (1942, pp. 298-307). One of these, the suposed longer tail of *tristis* is not confirmed by the present material. In the Arnhem Land specimens the tail length, combined head and body length ratio varies from 1·5-1·7 and in the South Australian Museum specimens of *orientalis* from 1·4-1·7; in the *tristis* material the variation is 1·6-1·8. Except in cases where the difference is paramount, the taxonomic value of this character is limited because of the difficulties in accurately measuring the body lengths of many preserved specimens and in determining whether or not the last few centimeters of tail are present.

The measurements and tail/head and body ratio of the adult specimens taken by the expedition:

Specimen Number	Sex	Total length	Head and Body length	Tail length	Tail length Head and Body length
128484	♂	520	194	327	1·7
128485	♂	499	187	312	1·7
128486	♂	487	182	305	1·7
128487	♀	465	185	280	1·5
128488	♂	497	185	312	1·7
128489	♂	451	172	279	1·6
128490	♀	405	160	245	1·5
128492	♂	350	130	220	1·7
128387	♀	440	165	275	1·7
128574	♀	480	190	290	1·5

Several additional adults obviously possess incomplete tails.

Although comparatively constant in specimens from the one locality, the body scalation of this species varies markedly from one locality to another. The scales vary both in shape and relative density. The latter variation can be illustrated by counting the number of micro-scales. In the Arnhem Land specimens the dorsal scales are separated by as many as five rows of micro-scales, while in others, notably those from Tennant Creek, by only one or two rows. Fry (1913, fig. 7) figures 1-2 rows for his Eidsvold specimens, while the three South Australian Museum specimens, from the type locality possess 2-3. Further, the relative size of these micro-scales varies. The number bordering each dorsal

varies from an average of eight for the Stewart River specimens to fourteen for those from Tennant Creek; the average is twelve in the Arnhem Land series. Fry (*op. cit.*, fig. 8) figures eighteen for his *punctatus* var. *typica*. In some specimens there is a tendency for the micro-scales to become fused, forming larger elongate scales along the lateral borders of the dorsals. Working on a limited number of specimens, this variation does not appear to be significant, although the examination of a larger series may reveal grounds for the subdivision of the material at present referred to *tristis*. Plate xxxvii contains photographs illustrating this variation in both *tristis* and *orientalis*.

The number of abdominal scales averages 84 in a range of 79-94 in the Arnhem Land specimens and 90 in a range of 85-104 in the South Australian Museum series of *tristis*.

Two gravid females were opened, one U.S.N.M. 128574, contained twelve eggs, while the other, U.S.N.M. 128287, contained eight.

The largest specimen examined, S.A.M. R.3085, a male from the Frazer Range, W. Aust., originally recorded by Stirling and Zietz (1893, p. 170), measures 694 (265+435) mm., while the largest Arnhem Land specimen, U.S.N.M. 128483, also a male, measures 465 (210+255+) mm.—tail incomplete.

FAMILY PYGOPODIDAE

DELMA FRASERI FRASERI Gray

Delma fraseri Gray, 1831, p. 14.

Delma plebeia De Vis, 1888, p. 825.

U.S.N.M. 128679-128682, Yirrkalla, N.T.

U.S.N.M. 128260, Nightcliff, near Darwin, N.T.

A.M. R.13648 (2 specimens), R.13569 (2 specimens), R.13570 (2 specimens), Cape Arnhem, N.T.

A.M. R.13471, Groote Eylandt, N.T.

The anal scalation of this material is interesting as it confirms that *plebeia* De Vis is a variant of *fraseri*, as was suggested by Longman (1916, p. 51) and Kinghorn (1926, p. 53). Although all of the present series possess three anal scales, the size and position of the median scale varies considerably; the outer anals accordingly vary from widely separated by the median anal to forming a median suture, thereby excluding the median anal. (See fig. 4.) Probably the median anal is present in the type of *plebeia*, but its position and size make it of little apparent significance.

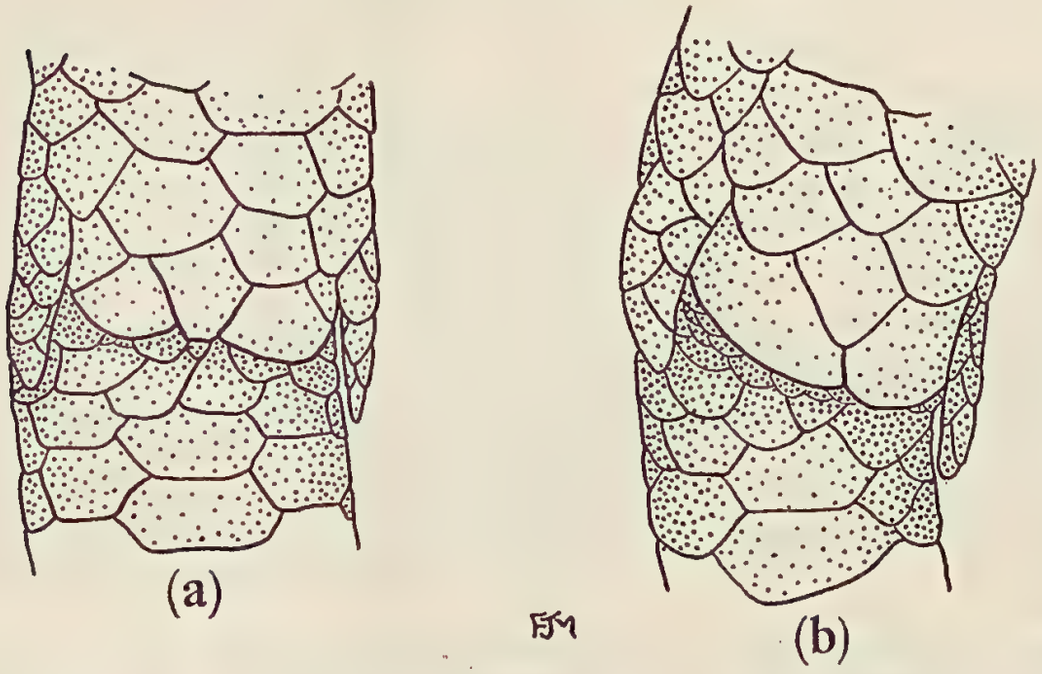

Fig. 4. *Delma fraseri fraseri* Gray: drawings of the anal region showing, (a) the var. *typica* condition and (b) the var. *plebeia* condition. Both drawings were made from specimens taken at or near Yirrkalla, N.T.

LIALIS BURTONIS Gray

Lialis burtonis Gray, 1834, p. 134.

U.S.N.M. 128379-128383, 128441, A.M. R.13610 (3 specimens), Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128467-128468, Port Langdon, N.T.

U.S.N.M. 128259, Nightcliff, near Darwin, N.T.

U.S.N.M. 128576, Yirrkalla, N.T.

U.S.N.M. 128504, Milimgimbi Island, Crocodile Islands, N.T.

U.S.N.M. 128514, Kuraiturumuru, N.T.

A.M. R.13546, Oenpelli, N.T.

FAMILY SCINCIDAE

TILIQUA SCINCOIDES INTERMEDIA subsp. nov.

Holotype: S.A.M. R.3095, an adult male, Yirrkalla, N.T.

Paratypes: U.S.N.M. 128636-128637, 128639, Yirrkalla, N.T.

S.A.M. R.3225, near Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128478, Port Langdon, N.T.

Diagnosis: Differs from the southern Australian race in possessing a distinctive colour pattern and in attaining a larger adult size.

Scalation: Midbody scales in 32-35 rows, irregular in the dorso-lateral region of the body. Prefrontals narrowly separated or making point contact on the midline; nasals invariably separated. Nine or ten upper labials with the 5th, 6th and 7th or 6th, 7th and 8th subocular; 6-7 supraciliaries; 2-3 auricular lobules.

Colouration: The most distinctive feature of this race is its colour pattern. In the type race the dorsal surfaces of the body and tail have a uniform patterning of alternate light and dark crossbands; in *intermedia* this banding is broken up into a series of alternate light and dark bars on the dorso-lateral surface only, none of the bars extending to or across the dorsal midline. Furthermore, the bars are staggered along the body, a dark bar on one side facing a light bar on the other. The middorsal colouring is darker than the light bars, but with a light blotch the same shade as the light bars at the dorsal end of each dark bar. The dark temporal streak is not as prominent as in the type race.

This somewhat complicated colour pattern is constant in all specimens examined, including the South Australian Museum specimens recorded by Mitchell (1950, p. 295).

Measurements: The largest specimen examined is the holotype and it measures 447+ (334+113+) mm.—tail incomplete. All specimens examined, except the juvenile (U.S.N.M. 128388) possess body lengths in excess of 300 mm. Of twenty-one South Australian specimens of the type race examined, the largest measure 293 mm. from the tip of the snout to the vent.

LYGOSOMA (SPHENOMORPHUS) TAENIOLATA (Shaw)

Lacerta taeniolata Shaw, 1790, p. 245, pl. xxxii, fig. 1.

U.S.N.M. 128758, S.A.M. R.2868, Oenpelli, N.T.

U.S.N.M. 128756, East Alligator River, N.T.

LYGOSOMA (SPHENOMORPHUS) ESSINGTONII (Gray)

Tiliqua essingtonii Gray, 1842, p. 51.

U.S.N.M. 128251-128256, Nightcliff, near Darwin, N.T.

U.S.N.M. 128603-128607, 128609-128610, Yirrkalla, N.T.

U.S.N.M. 128402-128407, A.M. R.13466 (2 specimens), R.13467 (3 specimens), S.A.M. R.2866 (7 specimens), Umba Kumba, Groote Eylandt, N.T.

Loveridge (1934, p. 346) raises the question of the affinities of *T. essingtonii* Gray and suggests that it may be more nearly allied to *leonhardii* Sternfeld than *taeniolata* Shaw. Although varying a little, the colouration of this series of 31 specimens agrees well with Gray's type and Boulenger's catalogue descrip-

tion (1887, p. 228) of this species. An examination of the scalation supports Boulenger's statement (*op. cit.*) that it differs in no way from that of *taeniolata* Shaw.

The colour and pattern are distinctive. A broad dorsal stripe varies from light brown in the Nightcliff specimens through light bronze to almost cream in some of the Groote Eylandt material. This is bordered on each side by a wide, light edged, dark dorso-lateral stripe, which breaks up into a series of dark spots on the tail. The light upper edge of this stripe is defined on the nape and anterior half of the body by a further dark line, which is particularly prominent in the Nightcliff specimens. In the Yirrkalla and Groote Eylandt specimens a series of 16-24 bronze blotches are enclosed within the dark dorso-lateral stripe. In the Nightcliff series there are only occasional small lighter spots in the anterior half. Limbs bronze, spotted or striated with black. Upper labials and ventral surfaces white.

LYGOSOMA (SPHENOMORPHUS) SPALDINGI (Macleay)

Hinulia spaldingi Macleay, 1877, p. 63.

U.S.N.M. 128594-128595, 128548, 128600, 128585, Yirrkalla, N.T.
U.S.N.M. 128391, S.A.M. R.2851, Umba Kumba, Groote Eylandt, N.T.
A.M. R.13576 (part), Cape Arnhem, N.T.

LYGOSOMA (SPHENOMORPHUS) LEONHARDII (Sternfeld)

Lygosoma (*Hinulia*) *taeniolatum* var. *maculata* Rosen, 1905, p. 140.
Lygosoma (*Hinulia*) *leonhardii* Sternfeld, 1919, p. 79.

U.S.N.M. 128577-128584, 128586-128593, 128596-128597, 128599, 128601, 128608, 128618, S.A.M. R.2860, Yirrkalla, N.T.

U.S.N.M. 128389-128390, 128392-128401; S.A.M. R.2869; A.M. R.13605 (3 specimens), R.13602 (3 specimens), R.13611 (1 specimen), R.13465 (1 specimen), R.13514 (2 specimens), R.13603 (3 specimens), R.13508 (2 specimens), R.13597 (3 specimens), Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128757, S.A.M. R.2867, Oenpelli, N.T.

A.M. R.13655 (2 specimens), R.13577 (2 specimens), R.13576 (1 specimen), Cape Arnhem, N.T.

The variation displayed by this large series is as follows: Midbody scales in 28 rows (16 specimens) or 30 rows (24 specimens)—only the adults were counted. Nasals separated behind the rostral in all specimens; prefrontals forming a variable length median suture; ear opening oval, relatively smaller in the adult than in the juvenile; 3-5 auricular lobules, the shape of each varying from obtuse to very acute. A subnarial suture is present in many specimens. Two

or three pairs of enlarged nuchals. All specimens possess four supraoculars except U.S.N.M. 128582, which has only three, there being an indication of the fourth suture at the supraciliary border. The second anterior supraocular is invariably the largest. Except for two specimens which possess six on one side and five on the other, all specimens have five upper labials anterior to the first subocular. The length of the snout seems to be very variable with consequent variation in the shape and size of the loreals and proportions of the prefrontals and internasal.

The colour and pattern show some variation. Many adult specimens are without a black vertebral stripe, and when some vestige of this line is evident, it is usually without the white border characteristic of specimens taken further south.

Some interesting variation in the size and shape of the supraoculars is also evident from this study. Although the size of the second supraocular is variable in all populations examined, there appears to be a south to north gradation tending toward an enlargement of this supraocular, its average size in the Arnhem Land specimens being markedly greater than that of South Australian skinks examined. (See fig. 5.)

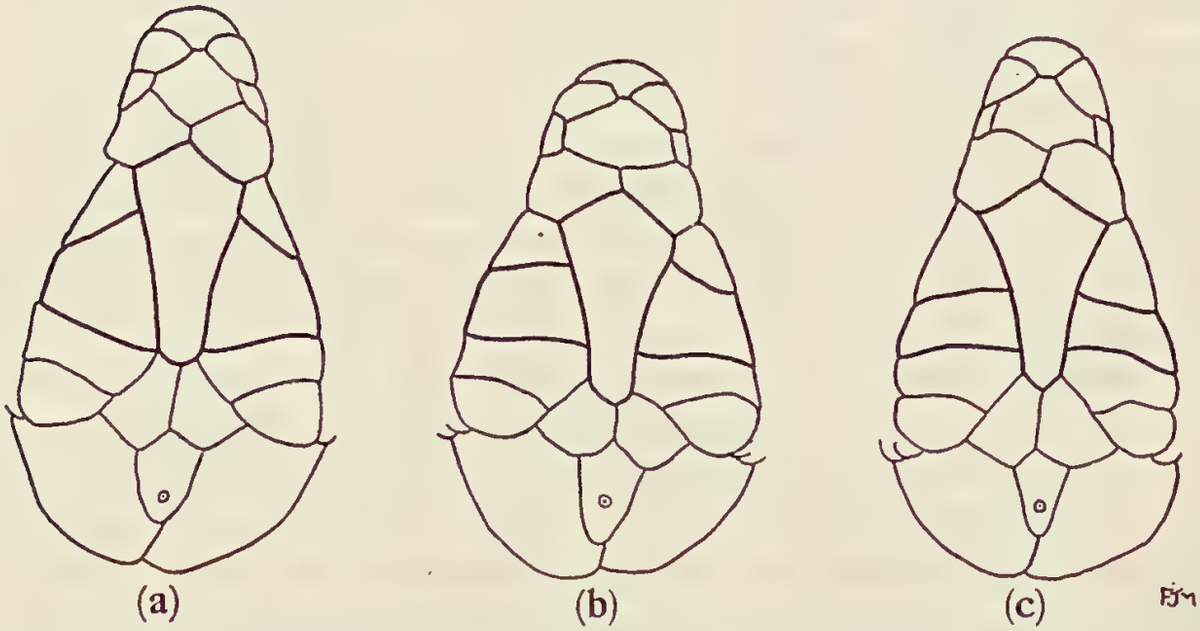

Fig. 5. *Lygosoma* (*Sphenomorphus*) *leonhardii* Sternfeld: three drawings illustrating the variation in supraocular scalation and its correlation with latitude. (a) U.S.N.M. 128608, Yirrkalla, N.T.; (b) S.A.M. R.1532, Hermannsburg Mission, N.T. (type locality); (c) S.A.M. R.3177, Mern Merna, S. Aust.

LYGOSOMA (SPHENOMORPHUS) ISOLEPIS ISOLEPIS (Boulenger)

Lygosoma isolepis Boulenger, 1887, p. 234, pl. xv, fig. 1.

U.S.N.M. 128506, S.A.M. R.3249, Milimgimbi Island, Crocodile Islands, N.T.
U.S.N.M. 128250, Nightcliff, near Darwin, N.T.
U.S.N.M. 128512, Larporkuru, N.T.
A.M. R.13606 (2 specimens), R.13468 (3 specimens), Groote Eylandt, N.T.
A.M. R.13549, Arnhem Land, N.T.
A.M. R.13654, Cape Arnhem, N.T.
A.M. R.13641, East Alligator River, N.T.

LYGOSOMA (LYGOSOMA) CRASSICAUDUM Dumeril

Lygosoma crassicaudum A. Dumeril, 1851, p. 172.

U.S.N.M. 128611, Yirrkalla, N.T.

Midbody scales in 20 longitudinal rows; four pairs of enlarged nuchals, contracting in size to a double series of slighlty enlarged vertebrals. Auricular opening round, without lobules; approximately one-third the horizontal diameter of the eye. The axilla to groin measurement is approximately one and three-quarter times longer than that from the tip of the snout to the forelimb. The hindlimb measures 14 mm., a length equal to the distance between the centre of the eye and the forelimb. Fifth upper labial centrally subocular; frontonasal forming broad sutures with both rostral and frontal, the suture in each case being a little more than half the frontonasal length. The maximum combined length of the frontoparietals and interparietal is a little greater than that of the frontal. Subdigital lamellae smooth, 5, 7-8, 12-13, 18-19, 8-9 being the formula for the hindlimb and 5,8,8,6,4, the formula for the forelimb. Dorsal surfaces dark brown, minutely punctate with black; the black spots becoming more prominent as the basic colour lightens ventro-laterally. Upper labials and underside of tail also punctate with black. Remaining ventral surfaces uniform white. The limbs have longitudinal rows of black spots.

This specimen measures 78+ (56+22+) mm.—tail incomplete.

Although it possesses the long frontonasal-frontal and frontonasal-rostral sutures stated to be characteristic of *mjobergi* Lonnberg and Andersson (1915, p. 6), this specimen has the larger number of subdigital lamellae of *crassicaudum*. While confidently claiming on the evidence of an examination of a specimen from Ravenshoe, Qld., referred to *mjobergi* by Proctor (1923, p. 1073), and another without locality data, that these two names refer to distinct species, Loveridge (1934, p. 367) refers the latter specimen which possesses only twelve lamellae beneath the fourth toe to *crassicaudum*. If correct, this would greatly reduce the value of the hindlimb lamellar formula as a taxonomic character for the separa-

tion of these two lizards. Similarly, the validity of the relative lengths of the frontonasal sutures as a distinguishing feature is endangered if this specimen has been correctly referred to *crassicaudum*.

A comparison with the literature also shows the following characters to vary. The Arnhem Land specimen and the type material as figured by Hombron and Jacquinot (1842-1853, pl. iv, fig. 1), have the fifth upper labial centrally subocular, while Lonnberg and Andersson record the fourth as being "below the centre of the eye" in the cotypes of *mjobergi;* Boulenger (1887, p. 325), after examining the specimens from Fly River, New Guinea, Murray and Cornwallis Islands records both conditions in his material. A suggestion of variation in the relative proportion of the frontonasal and in the number of supraoculars contacting the frontal is dependent on the accuracy of the Hombron and Jacquinot figure (*op. cit.*) which shows the frontonasal to be much longer than wide and the 1st, 2nd and 3rd supraoculars contacting the frontal. In colouration *mjobergi* is intermediate between that of the Arnhem Land specimen described above and that of typical *crassicaudum*. No evidence of a dark dorso-lateral stripe, sharply defined at its dorsal edge, is to be found in the present specimen, while some reference to this is made in all other relevant literature, including Macleay's *Lygosoma ornatum* (1878, p. 64).

Loveridge (*op. cit.*) mentions that *mjobergi* is a much larger species, a suggestion supported by the measurements of the larger cotype.

Genus LEIOLOPISMA

Because of the confused nomenclature in certain sections of this genus, it was found necessary to make a brief revision of the "Heteropus" species group, which is characterized within the genus by the possession of 4+5 digits and an undivided frontoparietal, to enable three of the species taken by the expedition to be satisfactorily identified. This revision has been published in the "Records of the South Australian Museum," xi, pp. 75-90, and the synonomies quoted below are discussed in it.

LEIOLOPISMA FUSCUM FUSCUM (Dumeril and Bibron)

Heteropus fuscus Dumeril and Bibron, 1839, p. 759.
Heteropus schmeltzii Peters, 1867, p. 23.
Heteropus tricarinatus Meyer, 1874, p. 133.
Heteropus longipes Macleay, 1877, p. 66.
Heteropus sexdentatus Macleay, 1877, p. 67.
Heteropus maculatus De Vis, 1885, p. 169.
Heteropus rubricatus De Vis, 1885, p. 170.
Heteropus rostralis De Vis, 1885, p. 171.

U.S.N.M. 128612-128617, 128518, Yirrkalla, N.T.
A.M. R.13583-13584, R.13656 (3 specimens), Cape Arnhem, N.T.

LEIOLOPISMA VIVAX (De Vis)

Heteropus peronii Dumeril and Bibron, 1839, p. 760.
Myophila vivax De Vis, 1884, p. 77.
Heteropus blackmanni De Vis, 1883, p. 168.

U.S.N.M. 128507-128510, Milimgimbi Island, Crocodile Islands, N.T.
U.S.N.M. 128257, Nightcliff, near Darwin, N.T.
A.M. R.13585 (4 specimens), R.13586 (4 specimens), Cape Arnhem, N.T.
U.S.N.M. 128439-128440, 128412; A.M. R.13464 (2 specimens), R.13470 (2 specimens); R.13607 (2 specimens); S.A. M. R.2857 (3 specimens), Umba Kumba, Groote Eylandt, N.T.
S.A.M. R.2865, Yirrkalla, N.T.

LEIOLOPISMA PECTORALIS (De Vis)

Carlia melanopogon Gray, 1844, pl. vii, fig. 1.
Heteropus lateralis De Vis, 1885, p. 168.
Heteropus pectoralis De Vis, 1885, p. 169.
Heteropus mundus De Vis, 1885, p. 172.
Lygosoma devisii Boulenger, 1890, p. 79. (n.n. for *lateralis* De Vis, as preoccupied in *Lygosoma*).
?*Lygisaurus foliorum* De Vis, 1884, p. 77.

U.S.N.M. 128764, Oenpelli, N.T.
U.S.N.M. 128528, Port Essington, N.T.

LEIOLOPISMA GUICHENOTI DELICATA (De Vis)

Mocoa delicata De Vis, 1888 (1887), p. 820.

A.M. R.13461, Groote Eylandt, N.T.

Midbody scales in 26 rows; no auricular lobules. General scalation similar to that of South Australian and Victorian specimens of *guichenoti,* but with a much wider frontonasal-frontal suture. Its general form is more slender and the limbs weaker. On the above evidence *delicata* is retained as a subspecies. The colour corresponds accurately with that described by De Vis, and if constant would distinguish it readily from the type race.

Loveridge (1934, p. 359) doubtfully referred *delicata* to the synonymy of *guichenoti,* commenting on the fact that all specimens of *guichenoti* possessed enlarged preanals, and that this feature was not characteristic of *delicata.* This is confirmed by material examined.

RHODONA STYLIS sp. nov.

Holotype: S.A.M. R.3094, Yirrkalla, N.T.

Paratypes: U.S.N.M. 128640-128678; S.A.M. R.2856 (5 specimens), Yirrkalla, N.T.

U.S.N.M. 128409-128411, S.A.M. R.2855 (2 specimens), Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128520, Rocky Beach, Cape Arnhem, N.T.

A.M. R.13566 (4 specimens), R.13567 (5 specimens), R.13568 (5 specimens), R.13657 (8 specimens), R.13658 (8 specimens), Cape Arnhem, N.T.

Diagnosis: This species most nearly approaches *Rhodona lineata* Gray in the degree of reduction of the limbs, but is immediately distinguished from it by the presence of frontoparietals and at least three supraoculars. The scalation closely resembles that of *Rhodona wilkinsi* Parker, with which it agrees in all essential details including the midbody scale count. However, the presence of a styliform hind limb immediately separates it from that species.

Type description: Body elongate; forelimb absent; hindlimb minute, styliform, variable in size (see fig. 7), but equivalent in length to two of the

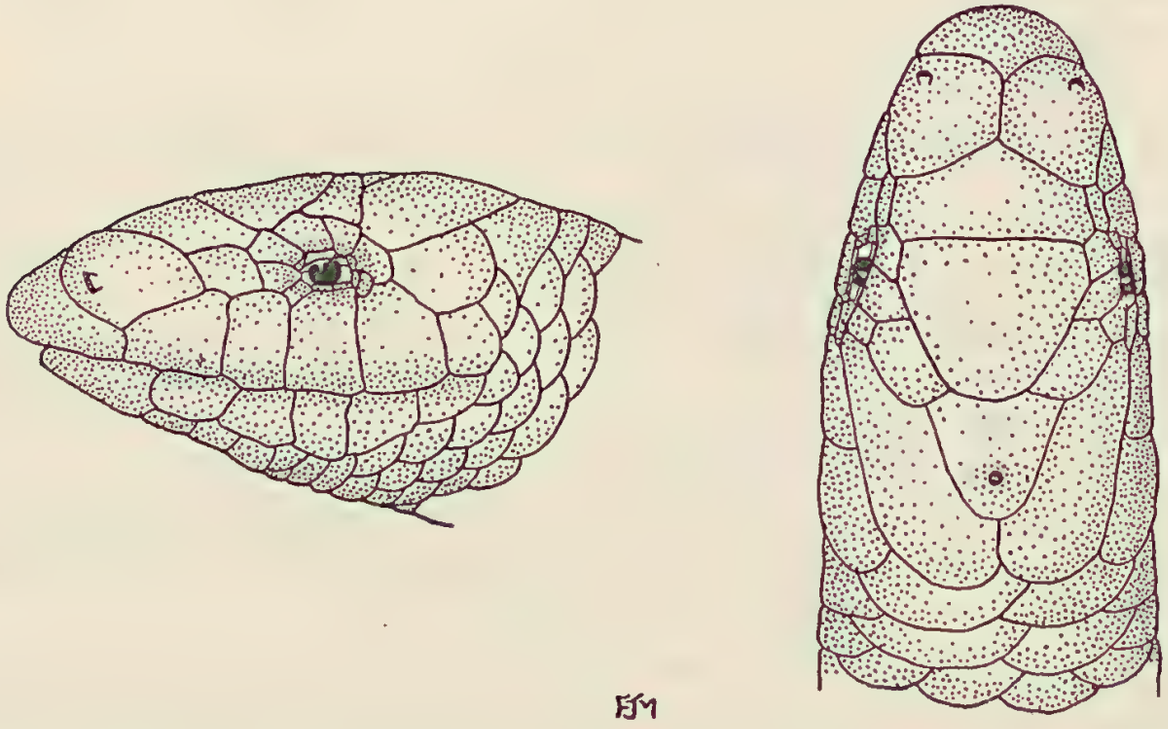

Fig. 6. *Rhodona stylis* Mitchell: dorsal and lateral views of the head of the holotype (×10 approx.).

adjacent scales in the holotype. Snout cuneiform with angularly projecting labial edge; eye small, lower eyelid with a large transparent disk. Three supraoculars; frontoparietals and interparietal distinct, the former being widely separated and less than half the size of the latter; parietals forming a suture behind the interparietal. A loreal and one or two preoculars; two postoculars. Five upper and five lower labials, the third upper labial being subocular; two pairs of enlarged nuchals and a pair of slightly enlarged anal plates present. Eighteen smooth scales at midbody. Ear opening minute.

Colouration: Light grey dorsally with a black dorso-lateral stripe extending from behind each eye to the tip of the tail. On the dorsal surface a longitudinal line of fine black dots extends down each side of the vertebral line, the two rows coalescing on the tail. Ventral surfaces uniform white.

Measurements: The holotype measures 113 (60+53) mm.—tail regenerating.

Variation: The head scalation is very constant within the type series of 82 specimens, the main variation being in the size and number of the small ocular and supraciliary scales. In several of the Groote Eylandt specimens the large postocular has been forced up into line with the supraoculars by the enlargement of several small scales at the posterior border of the eye, and it might therefore be considered an additional supraocular. The number of scales at

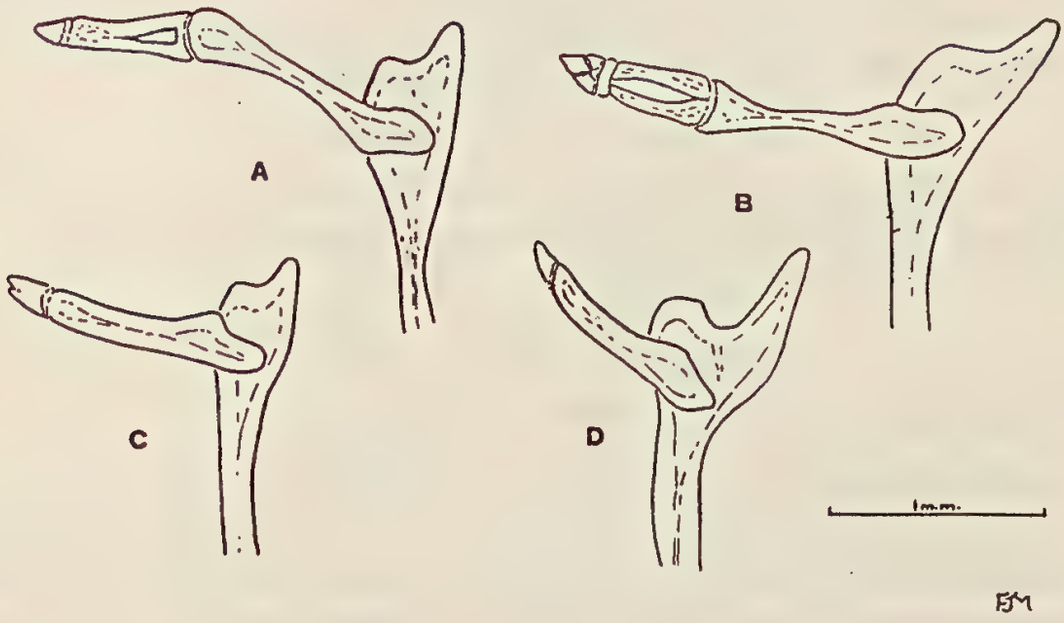

Fig. 7. Drawings of the bones dissected from within the styliform hindlimb of *Rhodona stylis* Mitchell.

A and B—specimens from Groote Eylandt, N.T.
C and D—specimens from Yirrkalla, N.T. (type locality).

The body lengths of the four specimens from which the bones figured above were taken are 60±2 mm.

midbody is usually eighteen, but the lateral scales are often irregular and in such cases twenty can often be counted, particularly in the Yirrkalla material. The basic midbody count for the Groote Eylandt skinks is sixteen, with eighteen occurring in the two specimens with irregular lateral scaling. Accepting midbody as being the middle point of the distance between the ear opening and the hind limb, fifty specimens were counted with the following results: eighteen specimens were found to possess 20 midbody scales, twenty-seven possessed 18, and five possessed 16. Many specimens have only four lower labials.

Although no point would seem to be gained by separating them, the Groote Eylandt specimens have several characters which distinguish them from the Yirrkalla series. Apart from the small scalation differences indicated above, they differ in possessing less degenerate hind limbs, some evidence of the tibia, fibula and tarsals being present. There is only a short rudiment of the tibiofibula present in the Yirrkalla lizards (see fig. 7).

The uniform degeneration of the limbs and digits in the genus *Rhodona* has been of considerable interest to the author, and limb dissections of the nine species available in the South Australian Museum collection have been made and studied. Although by no means conclusive, the variation in tarsal (carpal) and metatarsal (metacarpal) bones, particularly among specimens of the same species, but from different localities, suggests that the loss of digits and digital bones may not be always indicative of specific variation. The genus may be found to contain polytypic species within which the number of digits varies.

ABLEPHARUS TAENIOPLEURUS Peters

Ablepharus (*Morethia*) *taeniopleurus* Peters, 1874, p. 375.

U.S.N.M. 128759, Red Lily Lagoon, 7 miles W.S.W. of Oenpelli, N.T.
U.S.N.M. 128635, Yirrkalla, N.T.

ABLEPHARUS ORIENTALIS (De Vis)

Miculia orientalis De Vis, 1888, p. 160.

U.S.N.M. 128408, near Umba Kumba, Groote Eylandt, N.T.

Except for the possession of 20 instead of 18 midbody scales, this specimen corresponds accurately with De Vis's type description. De Vis (*op. cit*) refers to *orientalis* as the "eastern representative of *elegans* Gunther." This suggests subspecific relationship, and it is possible that the western and north-eastern populations do intergrade at some point in north-western Australia. Zietz (1920, p. 222) gives the distribution of *elegans* as Western Australia, South Australia, Central Australia, New South Wales and Victoria. Except for

Western Australia, I have been unable to find grounds for suggesting that the species occur in any of the States mentioned. The South Australian Museum collection contained 18-20 specimens which had been identified as *elegans*, but all are referable to *A. greyi* Gray or *A. timidus* De Vis. The occurrence of *elegans* in South Australia is therefore doubtful. The present specimen differs from the Western Australian *elegans* in possessing a higher number of midbody scales, the presence of only three upper labials anterior to the subocular and in the complete encirclement of the eye by small granular scales.

ABLEPHARUS BOUTONII METALLICUS Boulenger

Ablepharus boutonii var. *metallicus* Boulenger, 1887, p. 347.

U.S.N.M. 128619-128634, Yirrkalla, N.T.

U.S.N.M. 128413-128438; A.M. R.13469 (3 specimens), R.13592 (10 specimens), S.A.M. R.2852 (3 specimens), near Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128760-128763, S.A.M. R.2850 (3 specimens), 2 miles S.S.E. of Oenpelli, N.T.

U.S.N.M. 128232, 128258, Nightcliff, N.T.

A.M. R.13582 (5 specimens), R.13650 (7 specimens), Cape Arnhem, N.T.

SALIENTIA

FAMILY LEPTODACTYLIDAE

LIMNODYNASTES ORNATUS (Gray)

Discloglossus ornatus Gray, 1842, p. 56.

U.S.N.M. 128457-128458, Central Hill, Groote Eylandt, N.T.

U.S.N.M. 128274-128275, S.A.M. R.3250, Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128465-128466, Port Langdon, N.T.

CYCLORANA AUSTRALIS (Gray)

Alytes australis Gray, 1842, p. 56.

U.S.N.M. 128236-128239, Nightcliff, near Darwin, N.T.

This species is separable from its more slender ally, *C. alboguttatus* (Gunther) by the strong sculpturing of the upper surfaces of the maxillae, premaxillae and zygomatic processes of the squamosals. The occurrence of both species at Alexandra Station, N.T. (Loveridge, 1935, p. 13; 1949, p. 213, quoting Parker, 1940, p. 20) and Port Denison, Queensland (Parker, 1940, pp. 19-20) indicates that they coexist over a large range.

GLAUERTIA ORIENTALIS Parker

Glauertia orientalis Parker, 1940, p. 67.

U.S.N.M. 128276-128277, Umba Kumba, Groote Eylandt, N.T.

These two interesting frogs support Parker's type description in all respects, one paratype female having been taken on Groote Eylandt.

FAMILY HYLIDAE

HYLA CAERULEA (Shaw)

Rana caerulea Shaw, 1790, p. 248.

U.S.N.M. 128267, Umba Kumba, Groote Eylandt, N.T.
U.S.N.M. 128530, Yirrkalla, N.T.

HYLA RUBELLA Gray

Hyla rubella Gray, 1842, p. 57.

U.S.N.M. 128281, Umba Kumba, Groote Eylandt, N.T.

HYLA LESUEURII Dumeril and Bibron

Hyla lesueurii Dumeril and Bibron, 1841, p. 595.

U.S.N.M. 128719, Oenpelli, N.T.

This specimen agrees well with Gunther's type description (1867, p. 56) and Boulenger's redescription and figure (1882, p. 413, pl. xxvi. fig. 2), of the type of *nigrofrenata,* which name was placed in the synonymy of *lesueurii* by Loveridge (1935, p. 51).

HYLA PERONI (Tschudi)

Dendryhyas peroni Tschudi, 1838, p. 75.

U.S.N.M. 128715-128718, Oenpelli, N.T.

This species appears to be widely distributed in northern, eastern and southern Australia, having been recorded from the Northern Territory, Queensland, New South Wales, Tasmania, and I take this opportunity to record its occurrence in the lower reaches of the River Murray, at Tailem Bend, S. Aust. It seems probable that the species also occurs in Victoria.

Except for a darker and more variegated colour pattern, the South Australian specimens are not distinguishable from northern and eastern Australian specimens. In life these dorsal variegations contain numerous green flecks which are not evident in preserved material.

HYLA ADELAIDENSIS Gray

Hyla adelaidensis Gray, 1841, p. 447, pl. viii, fig. 2.

U.S.N.M. 128720-128725, S.A.M. R.3252, Oenpelli, N.T.

HYLA NASUTA (Gray)

Pelodytes nasutus Gray, 1842, p. 56.

U.S.N.M. 128268-128271, S.A.M. R.3253, Umba Kumba, Groote Eylandt, N.T.

U.S.N.M. 128459, Central Hill, Groote Eylandt, N.T.

U.S.N.M. 128462, near Old Mission, Groote Eylandt, N.T.

HYLA BICOLOR (Gray)

Eucnemis bicolor Gray, 1842, p. 57.

U.S.N.M. 128712-128714, Oenpelli, N.T.

U.S.N.M. 128686-128703, S.A.M. R.3251, Cahill's Landing, East Alligator River, N.T.

U.S.N.M. 128710-128711, Red Lily Lagoon, N.T.

The latter localities are within a mile or so of each other, approximately six miles west of Oenpelli, N.T.

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EXPLANATION OF PLATE.

PLATE XXXVII

Photographs showing the form and density of the middorsal (right) and basal third caudal scales of:

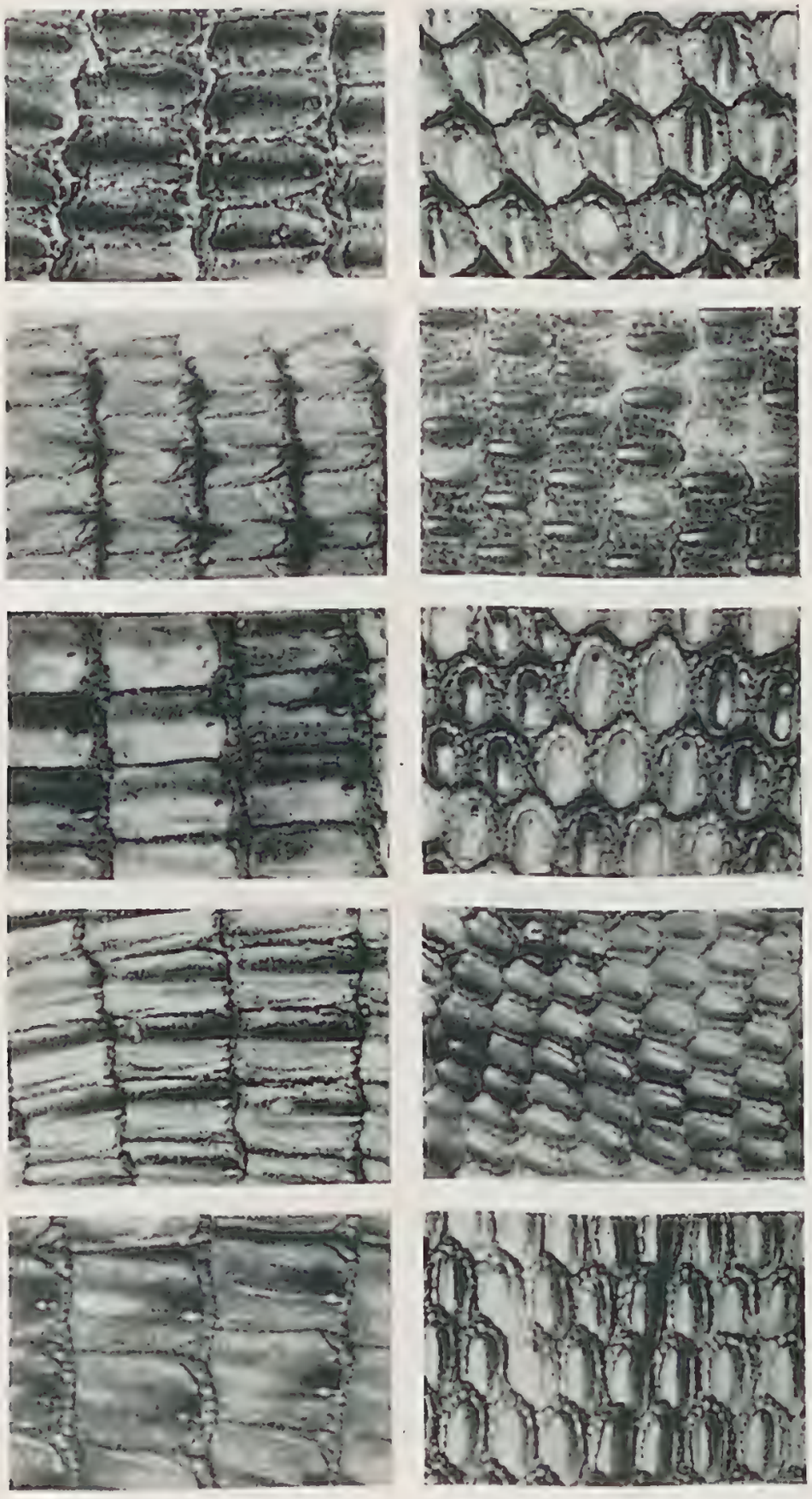
Varanus glebopalma Mitchell. Holotype.

Varanus timorensis tristis (Schlegel). Loc. Fraser Range, W. Aust.

Varanus timorensis tristis (Schlegel). Loc. Tennant Creek, N.T.

Varanus timorensis orientalis Fry. Loc. Eidsvold, Qld.

Varanus timorensis orientalis Fry. Loc. Groote Eylandt, N.T.



A REVISION OF THE FLOWER BUGS (HETEROPTERA ANTHOCORIDAE) OF THE AUSTRALIAN AND ADJACENT PACIFIC REGIONS — PART II

By GORDON F. GROSS, Assistant Entomologist,
South Australian Museum

Fig. 1

Genus Cardiastethus Fieber

Cardiastethus Fieber, 1860, Wien. Ent. Monat., 4, 266.

In addition to the reference in Van Duzee, 1917, Cat. Hem. Nth. Mexico, 295, there is Zimmerman, 1948, Insects of Hawaii, 178.

Body oblong or ovate pubescent. Rostrum surpassing anterior coxae. Posterior margin of pronotum deeply excavate, lateral margins straight or sinuate. The channel of the scent gland surpassing the middle of the pleurae and directed anteriad at the apex. Anterior tibiae usually armed with a row of short denticles on their inner side.

This genus is very well represented in the fauna of the regions dealt with here.

The species can be separated by the following key:

Key to Australian and Adjacent Regions Species of *CARDIASTETHUS*

1. Head much wider than long .... *C. inquilinus* China and Myers
   Head not, or little, wider than long 2
2. Small species, less than 2 mm. in length .... *C. poweri* White.
   Larger species more than 2 mm. in length 3
3. Second segment of antennae not longer than width of head across eyes .... *C. minutus* Popp.
   Second segment of antennae longer than width of head across eyes 4
4. Pronotum almost rectangular, anterior angles produced in front of the anterior margin (fig. 1C) .... *C. aridimpressus* sp. nov.
   Pronotum considerably broader posteriorly than anteriorly, anterior angles not produced 5
5. Cuneus in part rosaceous, male genitalia in the form of a large plate over 500μ long, female genitalia also very long (ca. 350μ) *C. consors* White
   Cuneus not rosaceous, male genitalia do not exceed 350μ nor the female genitalia 250μ 6
6. Brown species .... *C. lincolnensis* sp. nov.
   Light species, mainly yellow 7

7. Lateral margins of pronotum rounded with four long hairs on each side as well as the usual short pilosity. Hind margin of pronotum virtually straight. Terminal pair of antennal segments fairly short (172-210 : 220-240) .... *C. noumeensis* sp. nov.
Lateral margins of pronotum sinuate without four long hairs. Hind margin of pronotum excavate. Terminal pair of antennal segments longer (both 280-290) .... *C. fulvescens* (Walk.)

CARDIASTETHUS INQUILINUS China and Myers

Cardiastethus inquilinus China and Myers, 1929, A.M.N.H., (10) 3, 119.

Oval, dark brown shading to yellow brown towards apex of head and anterior lateral margins of pronotum. First and second antennal segments, rostrum, and legs yellowish.

Head short and broad, slightly longer than interocular width (17: 13), rostrum reaching apex of anterior coxae. Ratios of length of antennal segments 7:17:12:14 (same scale as above). Pronotum flattened with calli feebly elevated, distinctly but broadly impressed in the middle behind anterior lobe. Anterior margin straight, not emarginate.

Left genital style of the male conspicuously large and spathulate, strongly widened and truncate at apex. Length 2·1 mm.

Loc. South Australia. The original specimens were taken in the nest of an Oxyopid spider near Renmark, S.A.

CARDIASTETHUS CONSORS White

Fig. 1, A-B

Cardiastethus consors White, 1879, Ent. Mo. Mag. 16, 143.

'Yellowish, clothed with long pale hairs; head, pronotum anteriorly and posteriorly, and the abdomen dilutely reddish or yellowish fuscous; scutellum darker, cuneus exterolaterally rosaceous; hemi-elytra more or less fusconebulous; first segment of the antennae apically infuscated, second with the apical third fuscous black, third fuscous brown; membrane dilutely brownish fuscous with indistinct concolorous veins, near the base of the exterior vein a small triangular luteous spot. Vertex and the posterior part of the disc of the pronotum transversely rugulose, the latter with the lateral margins and the hind margin transversely punctate; scutellum subrugulose, the posterior lobe of the disc of the pronotum transversely impressed.

Length, 3 mm.' (translated from White's Latin description).

There are several specimens in the Woodward Collection available to the author for study which fit this description. From them the following standard measurements (in microns) have been obtained.

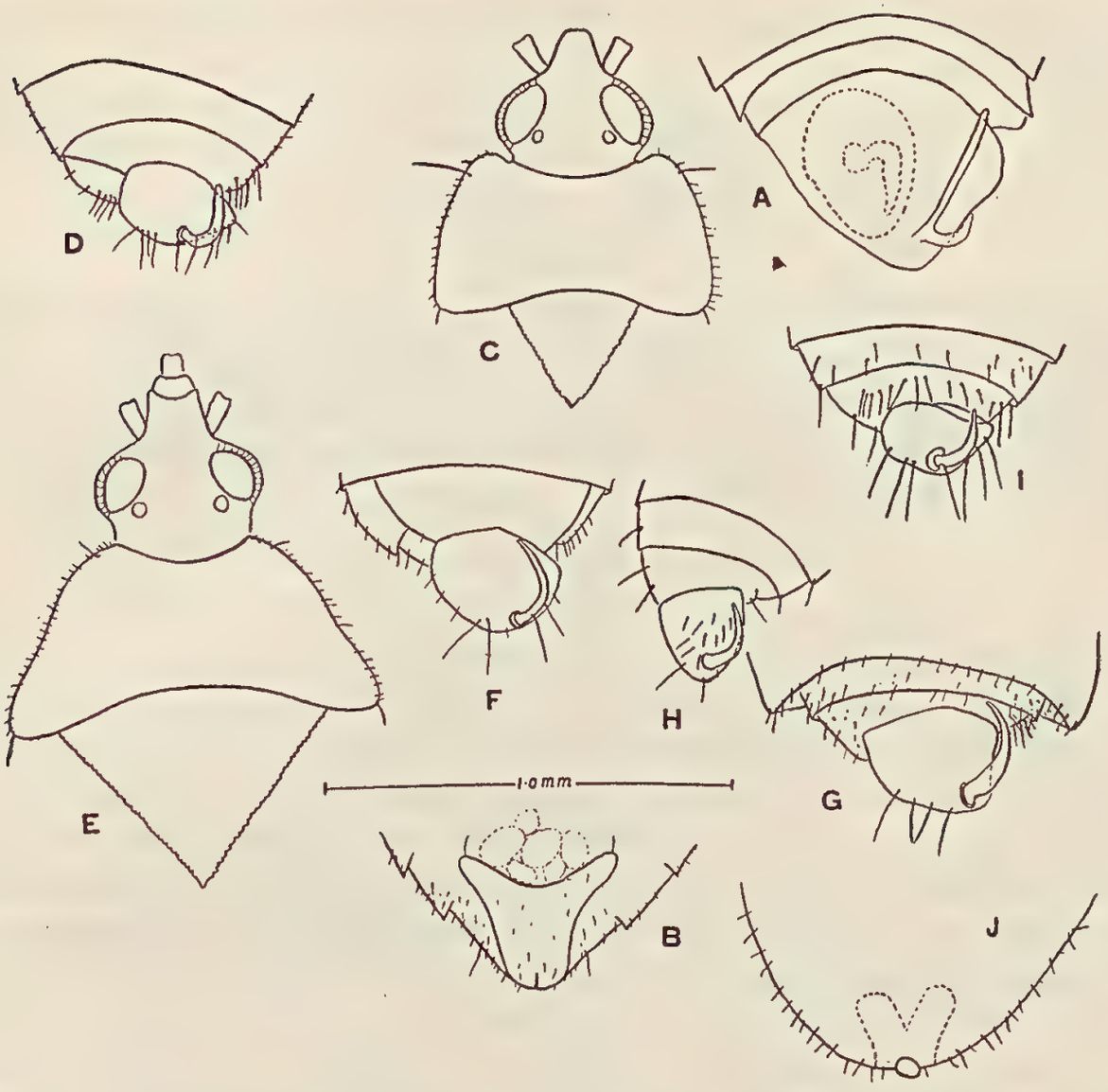


Fig. 1. A-B, *Cardiastethus consors* White. Male, A, apex of abdomen from below. Female, B, apex of abdomen from below. C-D, *Cardiastethus aridimpressus* sp. nov. Male. C, head and pronotum; D, apex of abdomen from below. E-F, *Cardiastethus lincolnensis* sp. nov. Male. E, head and pronotum; F, apex of abdomen from below. G, *Cardiastethus brounianus* White. Male. Apex of abdomen from below. H, *Cardiastethus fulvescens* (Walker). Male. Apex of abdomen from below. I-J, *Cardiastethus noumeensis* sp. nov. Male. I, apex of abdomen from below. Female. J, apex of abdomen from below. (All enlarged 40 diameters.)

Head. Length, 500-590; length in front of eyes, 170-210; length behind eyes, 120-140; length of eyes, 170-210; width across eyes, 410-470; width of eyes, 120-150; interocular, 190-210; width of collum, 360-460.

Antennae. I, 120-140; II, 500-530. Remaining segments missing on all specimens.

Rostrum. I, 140-160; II, 380-450; III, 260-280.

Pronotum. Anterior width, 380-470; posterior width, 930-1,000; median length, 400-470; lateral length, 550-600.

Scutellum. Anterior width, 590-650; median length, 450-470; lateral length, 480-550.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	260-320	500-530	520-600	50	70	120	30
II	210-240	520-550	520-640	50	70	120	30
III	310	640-740	800-900				

Total length, 2,810-3,450; total width, 1,030-1,410; length abdomen, 1,360-1,790; length male genitalia, 530; length female genitalia, 350.

Loc. New Zealand: Huia, Auckland (T. E. Woodward, 13 May, 1950, 4 specimens); Paiaka, Manawatu (T. E. Woodward, 8 January, 1950). All specimens in the Woodward Collection.

CARDIASTETHUS ARIDIMPRESSUS sp. nov.

Fig. 1, C-D

Dark brown. Legs, antennae and embolium yellow. Eyes black. Ocelli red. Rostrum paler brown. Membrane fuliginous. Pilosity yellowish.

Flattened oval pilose. Collum very short. Pronotum rectangular (fig. 1, C), slightly convex, marginate anterior angles produced somewhat in front of fore margin. Behind fore margin a slightly raised punctate callus. Collar tenuous. Scutellum triangular, plane, slightly depressed posteriad, with many denticulations laterally. All femora somewhat incrassated. Male genitalia in form of an angular plate with a hook-like process.

The standard measurements (in microns) from 4 specimens are:

Head. Total length, 380-460; length in front of eyes, 120-150; length behind eyes, 50; length of an eye, 200-270; width across eyes, 450-500; width of eye, 120-150; interocular, 170-240; width of collum, 320-400.

Antennae. I, 900-1,000; II, 310-330; III, 190-220; IV, 240.

Rostrum. I, 160-220; II, 330-430; III, 310-330.

Pronotum. Anterior width, 450-520; posterior width, 760-930; median length, 290-450; lateral length, 430-530.

Scutellum. Anterior width, 520-690; median length, 350-480; lateral length, 360-570.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	240-280	400-450	380-450	34	68	103	34
II	220-260	360-400	360-450	34	68	103	34
III	200-260	510-550	530-570	34	68	103	34

Total length, 2,400-2,800; width, 960-1,160; length abdomen, 1,150-1,580; length male genitalia, 240-330; length female genitalia, 172.

Loc. South Australia: Wilpena Pound (G. F. Gross, 3 August, 1951, Holotype ♂, Reg. Nos. E.S.I. 1480 and I20065), Mt. Lofty (Allotype ♀, Reg. No. I20066 and S. B. Curnow, Paratype ♂, Reg. No. I20067), Burnside (J. G. O. Tepper, 5 July, 1884, Paratype ♂, Reg. No. I20068).

CARDIASTETHUS LINCOLNENSIS sp. nov.

Fig. 1, E-F

Very similar in colouration to *C. aridimpressus*. Flattened, elongate oval, pilose. Collum quite long. Pronotum marginate. Lateral margin somewhat sinuate and diverging much more strongly posteriad than in *C. aridimpressus*. Collar tenuous. Scutellum triangular, plane, slightly depressed posteriad with many denticulations laterally. Femora not incrassated. Male genitalia very similar to *C. aridimpressus*.

The standard measurements (in microns) from 4 specimens are:

Head. Total length, 470-500; length in front of eyes, 170-210; length behind eyes, 90-120; length of an eye, 170-210; width across eyes, 400-470; width of an eye, 100-140; interocular, 170-210; width of collum, 330-380.

Antennae. I, 100-120; II, 350-430; III, 290-345; IV, 280-310.

Rostrum. I, 90-140; II, 400-470; III, 290-310.

Pronotum. Anterior width, 430-520; posterior width, 900-1,020; median length, 330-350; lateral length, 520-600.

Scutellum. Anterior width, 520-640; median length, 470-590; lateral length, 470-620.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	260-290	500-520	480-520	30	80	100-120	30
II	220-240	460-510	500-530	30	80	100-120	30
III	260	640-670	690-740	30	80	120	30

Total length, 2,070-2,870; width, 1,020-1,140; length abdomen, 1,240-1,480; length male genitalia, 290; length female genitalia, 170-210.

Loc. South Australia: Pt. Lincoln (A. M. Lea, Holotype ♂, Reg. No. I20069 and 1 paratype ♀, Reg. No. I20070), Lucindale (A. M. Lea, 1 paratype ♀, Reg. No. I20071); Tasmania: Daveystown (H. Felix, Allotype ♀, Reg. No. I20072); all in South Australian Museum.

CARDIASTETHUS POWERI White.

Cardiastethus poweri White, 1880, Ent. Mo. Mag. 16, 144.

'Piceous brown or piceous black, opaque, clothed with longish cinereous hairs; head anteriorly and posteriorly, pronotum laterally and posteriorly, also

the scutellum apically, embolium basally, clavus and the corium for the most part more or less lighter, sometimes lightly reddish. The third segment of the antennae fuscous brown, fourth reddish, a whitish fuscous nearly round spot before the base of the cuneus, membrane dilutely fuscous brown with three lighter markings, two basally, and the other on the inner margin, veins poorly defined. Rostrum basally piceous, apically somewhat yellowish, legs piceous brown, basally tending lighter in colour, femora apically, the apical half of the tibiae and usually the tarsi brownish yellow, body beneath a shining piceous brown, abdomen medianly lighter. Head and pronotum (anterior part of the disc excepted) transversely rugulose; scutellum lightly rugulose punctate, the posterior lobe of the pronotum anteriorly tranversely impressed or (♀) with a small deep fovea; membrane of the female shortened. Length, 1½-2 mm.' (translated from White's Latin description).

Loc. New Zealand.

CARDIASTETHUS BROUNIANUS White

Fig. 1, G

Cardiastethus brounianus White, 1878, Ent. Mo. Mag., 15, 159.

"Piceous brown, clothed with rather long pale hairs: clypeus, anterior margin of the embolium, and the corium rather paler, second joint of the antennae (apex excepted) and legs brownish yellow; membrane dark fuscous, with the outer three nerves margined with whitish. Head, pronotum and scutellum finely transversely rugose; transverse depression of the pronotum nearly obsolete; central depression of the scutellum rather shallow.

Length, 2-2½ mm." (White's description).

There are a number of specimens in the Woodward Collection which seem to fit this description. From some of them the following standard measurements have been obtained.

Head. Length, 450-480; length in front of eyes, 170; length behind eyes, 90; length of eyes, 190-210; width across eyes, 430-450; width of eyes, 100-120; interocular, 240; width of collum, 410.

Antennae. I, 100-120; II, 360; III, 220; IV, 240.

Rostrum. I, 160; II, 310-350; III, 260-310.

Pronotum. Anterior width, 450; posterior width, 1,000; median length, 430; lateral length, 570.

Scutellum. Anterior width, 410; median length, 430; lateral length, 480-500.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	—	520-550	500-520	—	—	—	—
II	—	520	500	—	—	—	—
III	310	670	—	—	—	—	—

Total length, 1,980; total width, 1,100; length abdomen, 1,120-1,210; length male genitalia, 350; length female genitalia, 210.

Loc. New Zealand: Cable Bay, N. Auckland (T. E. Woodward, 27 February, 1951, 3 specimens), Paiaka, Manawatu (T. E. Woodward, 15th January, 1950, by sweeping *Muehlenbeckia australis,* 9 specimens), South West Island, Three Kings (T. E. Woodward, 13 February, 1951, 10 specimens), Great Island, Three Kings, East Point (T. E. Woodward, 15 January, 1951, 3 specimens, *ditto* Tasman Valley, 1 specimen), Otaki River, South of Levin, Wellington Province (T. E. Woodward, 30 January, 1951, 3 specimens), Huia, Auckland (T. E. Woodward, 13 April, 1950, 1 specimen), and Punakitere, near Kaikohe, North Auckland (T. E. Woodward, 11 February, 1951, one specimen).

CARDIASTETHUS FULVESCENS (Walk)

Fig. 1, H

Xylocoris fulvescens Walker, 1872, Cat. Het. 5, 160.

Cardiastethus ? fulvescens Lethierry and Severin, 1896, Cat. Hem. 3, 250.

Amphiareus fulvescens Distant, 1904, A.M.N.H. (7) 14, 220. Faun. Brit. Ind. Rhynch. 3, 4, fig. 3.

Cardiastethus fulvescens Poppius, 1909, Act. Soc. Sci. Fenn. 37 (9), 19.

Xylocoris fumipennis Walker *loc. cit.*

Cardiastethus fumipennis Lethierry and Severin *loc. cit.*

Light yellow with long yellow hairs. Generally the apical margin of the corium and seldom the head, pronotum, clavus, the first segment of the antennae, and an apical band on the second, brown.

Sides of pronotum sinuate, disc deeply transversely impressed behind the middle, hind portion punctate. Scutellum medially broadly transversely impressed, anteriorly punctate, terminally striated.

The standard data (in microns) from the three specimens in the South Australian Museum are:

Head. Length, 380-480; length in front of eyes, 140-170; length behind eyes, 70-120; length of eyes, 170-190; width across eyes, 360-430; width of eyes, 120-140; interocular, 120-140; width of collum, 290-310.

Antennae. I, 100-140; II, 360-460; III, 280-290; IV, 280-290.

Rostrum. I, 140; II, 400; III, 210-260.

Pronotum. Anterior width, 310-330; posterior width, 760-810; median length, 310-460; lateral length, 430-570.

Scutellum. Anterior width, 430-570; median length, 330-400; lateral length, 360-450.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	240-290	480-530	510-580	—	—	—	—
II	220-260	480-530	600-670	50	70	100	30
III	260	620-720	770-930	90	100	140	30

Total length, 2,170-2,410; total width, 770-950; length abdomen, 1,070-1,090; length male genitalia, 280; length female genitalia, 120.

Loc. Distributed widely over an area from Ceylon to Queensland. There are three specimens in the South Australian Museum from Malaya: Gap, Frazer's Hill (A. M. Lea and wife), New Guinea; Mt. Lamington, N.E. Papua (C. T. McNamara), and Queensland: Cairns District (A. M. Lea, attracted to light).

CARDIASTETHUS NOUMEENSIS sp. nov.

Fig. 1, I-J

Yellowish brown, eyes reddish brown. Collum, collar of pronotum, and two large patches on the anterior angles, clavus, scutellum, cuneus, embolium apically, and underside brown.

Collum long, third and fourth segments of antennae short. Lateral margins of pronotum rounded with four long hairs and a number of shorter ones, fore margin straight, hind margin excavate. Pronotum strongly raised, immarginate, just anterior to middle a deep curved suture. Scutellum with strong denticulations laterally, impressed behind the middle. Clavus and posterior margin of corium punctate.

Upper surface longly pilose, anal end equipped with long hairs. Male genitalia in the form of a roughly semicircular plate, with about 7 long backwardly directed hairs.

The standard measurements (in microns) from four specimens are:

Head. Length, 380-550; length in front of eyes, 110-220; length behind eyes, 80-90; length of eyes, 160-190; width across eyes, 380-470; width of eyes, 120-160; interocular, 90-160; width of collum, 300-400.

Antennae. I, 90-100; II, 220-360; III, 170-210; IV, 190-240.

Rostrum. I, 120-170; II, 300-450; III, 170-240.

Pronotum. Anterior width, 210-430; posterior width, 830-1,000; median length, 410-450; lateral length, 450-500.

Scutellum. Anterior width, 430-517; median length, 220-360; lateral length. 280-430.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	260-330	380-480	380-470	30	50	90	30
II	190-220	360-460	410-500	30	50	90	30
III	190-260	480-600	620-750	50	70	100	30

Total length, 2,170-2,460; total width, 800-1,020; length abdomen, 1,030-1,330; length male genitalia, 190-270; length female genitalia, 140.

Loc. New Caledonia: Noumea (A. M. Lea, Holotype ♂, Reg. No. I20073, Allotype ♀, Reg. No. I20074, and two paratypes, Reg. Nos. I20075-76) in the South Australian Museum.

CARDIASTETHUS MINUTUS Poppius

Cardiastethus minutus Poppius, 1909, Act. Soc. Sc. Fenn. 37 (9), 20.

Shining, hemielytra duller, clothed with short semi-erect brown hairs. Apical part of corium and cuneus, the second segment of the rostrum and the third and fourth antennal segments brown.

Head depressed, second segment of the antennae not longer than the head is wide, rostrum reaches the fore coxae. The disc of the pronotum is fairly deeply excavate behind the middle and transversely impressed. Corium and clavus very obscurely punctate. There is one specimen belonging to this species in the South Australian Museum and its standard measurements are:

Head. Length, 360; length in front of eyes, 140; length behind eyes, 90; length of eyes, 110-140; width across eyes, 330; width of eyes, 100-120; interocular, 100; width of collum, 260.

Antennae. I, 90; II, 220; remaining segments missing.

Rostrum. I, 90; II, 280; III, 220.

Pronotum. Anterior width, 330; posterior width, 720; median length, 310; lateral length, 600.

Scutellum. Anterior width, 400; median length, 350; lateral length, 360-380.

Legs	coxa	femur	tibia	tarsi I	II	III	cl.
I	—	380-400	380-410	30	70	90	30
II	170	350-380	410-430	30	70	90	30
III	170-190	450-470	580-600	30	90	100	30

Total length, 2,300; total width, 830; length abdomen, 1,100; length male genitalia, 170.

Loc. New Guinea: Mt. Lamington, N.E. Papua, 1,300-1,500 ft. (C. H. McNamara).

PORONOTELLUS Kirkaldy

The genus *Poronotellus* has proved to be rather common in these regions and the species have proved extremely difficult to separate. To date it has not proved possible to come to any definite conclusions about the status of forms. Accordingly, it is intended to investigate more fully this problem and to present the results in a further paper to comprise, together with additional material on species in the other two subfamilies, part III of this revision.

Therefore the sections of the ecology and zoogeography of the Anthocoridae have been introduced here, instead of at the end of the whole systematic account as originally intended.

ECOLOGY OF ANTHOCORIDAE

The minor habitats occupied by Australian and Pacific Anthocoridae are fairly varied. Those species of *Cardiastethus* for which the minor habitat is known are all subcortical, especially on eucalypts, with the exception of the two type specimens of *Cardiastethus inquilinus* China, which were found in an Oxyopid spider's nest. This spider's nest was located in a mallee area of South Australia in which in the main the only vegetation is depauperate species of *Eucalyptus,* mostly of the peeling "gum barked" type. These mallees very nearly duplicate the minor habitat of such eucalypts as *Eucalyptus camaldulensis* on which *C. aridimpressus* nov. frequently occurs. Therefore it is not unlikely that *C. inquilinus* is also usually subcortical under eucalypt bark.

The widespread *Xylocoris flavipes* Reuter. occurs in stored grains. The family seems definitely to be predaceous, though it is not clear whether all are egg predators like are *Orius australis* (China) and *Orius insidiosus* (Say) or whether some of the litter dwelling forms feed also on Collembola and mites. The habits of *Xylocoris flavipes* and of *Cardiastethus* spp. suggest that they may be egg predators for adult animals small enough for them to feed on, are rare in their two preferred minor habitats.

The widespread *Lyctocoris campestris* (Fab.) is at home in crevices and cracks in man made dwellings and is the only Anthocorid known to bite man.

The remaining forms all seem to be most likely associated with the litter layers of the forest floor. This has been proven for *Falda queenslandica* Gross and several species of *Lasiochilus.*

The members of the family are definitely favoured by hot and warm conditions. There are therefore considerably more species in the tropics than in the temperate zones, and in any given temperature zone more species in the forest major habitats than in adjacent grassland or desert. Of the known Australian species only *Lyctocoris campestris, Cardiastethus inquilinus* and *C. aridimpressus* occur in major habitats drier than dry sclerophyll forest. On the other hand, no fewer than twelve species occur in the Queensland wet forests.

ZOOGEOGRAPHY OF AUSTRALIAN ANTHOCORIDAE

This preference for hot and wet conditions of Anthocoridae described above has considerable bearing on their use in helping to elucidate the puzzling facts of the present distribution of the Australian biotas and its relation to past climatic history.

The present primary disjunction of the terrestrial biotas is largely a resultant of the distribution of land and sea in past geological ages. Within any one area which has had a geological history of relative stability and unity, any disjunction now evident is mostly an outcome of the past climatic history. Some groups of the biota (e.g., plants and their associated herbivorous insects) are affected more than others (e.g., mammals, carnivorous insects, etc.) by these climatic changes.

In Australia the biota has at least two distinct elements with perhaps two, possibly three, other elements. The first of these is the "old world tropical" or "northern" element variously called Tropical, Torresian, Papuan or Indo-Malayan. The last has priority but does not necessarily reflect the origin of the element, merely its present centre of distribution and the pathway by which it entered Australia. Some constituents may be but birds of passage in the Indo-Malayan tropics, having perhaps had their greatest period of development in the northern temperate areas. This Indo-Malayan element includes amongst animals the insect families Anthocoridae, Pyrrhocoridae, Flatidae, Ricaniidae, etc. (Hemiptera) Papilionidae (Lepidoptera), etc., and of the vertebrate groups the whole of the Australian eutheria and metatheria and modern Australian reptiles and amphibians. The Indo-Malayan element of the flora includes such genera as *Eugenia, Ficus, Terminalia, Erythrina* (Coral trees), *Cochlospermum* (Kapok trees), *Adamsonia* (Baobab), *Cocos* (Coconut palm) and *Pandanus*. Also (see Eyrian element) *Hibiscus, Malva, Acacia, Cassia* and *Eucalyptus* are really a part of this biota. Generally members of this element tend to be limited by the southern boundary of the northern Australian tropical forest, savannahs and savannah woodlands.

The second element of the biota is the so called "southern" element whose members show three different types of distribution, namely:

(1) Endemic to Australia and adjacent regions, e.g., Casuarinaceae in the plants and Melolonthinae (Coleoptera) amongst the animals.

(2) Affinities with New Zealand and often South America, e.g., the plant genera *Nothofagus, Araucaria,* part of the family Podocarpaceae and the family Epacridaceae and the animal groups Peloridiidae, Isoderminae (Hemiptera), part of the Tiphiidae (Hymenoptera), and of the Dynastinae (Coleoptera).

(3) Affinities with South Africa and Madagascar only (Proteaceae, part of Podocarpaceae).

Some authors recognize one or more of these three as being entirely different biotas, but it will probably prove that (2) and (3) are but wider ranging wind borne or island hopping members of (1), which extended their distribution during Pleistocene and earlier changes of sea level. This whole southern element, or various parts of it, has been called by a variety of names (e.g., Antarctic, Bassian and Autochthonian) and it generally tends to be limited by the northern border of the southern humid regions.

Lastly, there is the desert biota. This has been considered a distinct element by some authors (e.g., "Eyrean" of Spencer and "Eremian" of Tate), but this can only be justified on the basis of the great modification that plants and most animals must adopt in order to survive in the desert. Apart from these physiologically essential modifications, the Australian desert biota is clearly comprised of demonstratable elements of the contiguous "northern" and "southern" biotas. Actually, in plants it is much the same group the world over that may enter desert or similar areas, e.g., *Acacia* (Australian, African, Asian and North American deserts, note also the closely related North American *Prosopis*), *Atriplex* (Australian, African, Asian and North American deserts), *Triodia* (Australian, Asian and North American deserts), and many others.

This restriction on what groups of plants and animals can enter desert regions, together with the tendency of strong prevailing winds to blow around the world latitudinally (e.g., parallel to the deserts, not across them) may well explain the primary disjunction of the Australian biota into two or (counting the Eyrean) three elements. For if the continent has been divided latitudinally by the same belt of desert as now exists (this would have extended probably from coast to coast before the Mount Kosciusko and New Guinea uplifts), the southern element would have been effectively isolated from the northern. If this

state of affairs came into being at the beginning of the Tertiary, the "southern" element would have had time to develop its distinctive features.

We cannot assume this barrier to have been any earlier than the beginning of the Tertiary, for during the Upper Cretaceous plant species were notoriously widespread. During the progress of the Tertiary progressive restriction of distribution is evident in plants. (Cookson and Pike, 1953, a, b, 1954; Cookson, 1953, a, b, 1954).

The presence of a few members of the one element in the area occupied in the main by members of the other, and the presence of both together in the desert, seems to be explicable mostly on the basis of desert adaption, for it is usually groups capable of desert adaption that occur in the region of the other element. A whole suite of adaptable genera of the Indo-Malayan element has moved into the desert from the north (*Acacia, Cassia, Malva, Eucalyptus, Hibiscus,* and *Melaleuca* amongst the plants) or has been trapped in favourable pockets during one of the north or south oscillations of the position of the continuous band of desert (in plants *Livistona mariae, Macrozamia macdonnelli,* and *Ficus platypoda*) with some actually crossing the southern boundary of the desert into the southern humid formations (*Acacia, Eucalyptus, Melaleuca*). Equally, a group of adaptable genera were able to penetrate the desert from the south and usually make their way through to the north (*Hakea, Grevillea, Brachychiton* amongst the plants).

At the end of the Pliocene the Kosciusko uplift formed a moist corridor of forest formations traversing the area formerly covered by part of the desert and breaking the continuity of this belt in the east. This gave considerable opportunity for mixing the "northern" and "southern" elements, and this seems to have occurred. As is to be expected, the greatest mixing has occurred in this north-south moist corridor with the effect falling off the further the distance from the corridor until, in such places as the Darwin and Perth areas, practically the only members of an extraneous element present are those that have come through via the desert. No group shows the effect of this moist corridor better than the Anthocoridae, for this undoubtedly tropical or "northern" group have fourteen species in Queensland, six in New South Wales, five in Victoria, five in South Australia (one of which is introduced), and one (introduced) in Western Australia.

This theory of the permanence of the desert belts is not in accord with the concept of a vast aridity covering the whole continent as postulated by Crocker and Wood (1947) during the "mid recent high" in sea level. Their "great arid" hypothesis is at the moment under criticism from other quarters. Tindale

(1947, a and b, 1949, 1952) and Condon (1954) have shown that most zoological data, and even a considerable part of the botanical distributions employed by Crocker and Wood as proof of their "great arid," are better explained by assuming a steady increase in aridity in the southern regions from the end of the Pleistocene right up to the present. This may involve a steady shifting south of the desert belt.

Some investigations of the author have tended to confirm these later views. The discovery of "myall" (*Acacia sowdeni*) growing near the southern end of Lake Eyre South suggests rather an earlier continuous belt of "myall" stretching from Kingoonya around the north end of Lake Torrens to the Broken Hill district and disjoined into two species by the present aridity rather than that the distribution of the two species, *A. sowdeni* and *A. loderi* reflects emergence from refuges in the Gawler Ranges and Flinders Ranges into which they retreated during the "great arid." The Gawler Ranges would provide little or no better conditions for such a plant than the surrounding countryside for the ranges themselves are of porphyry, onto which myall never ventures, with wide loam flats (on which myall now occurs) between, and which receive little, if any, more rain than the main areas of myall distribution.

Even more difficult to explain by the "great arid" are the presence of such forms as *Cardiastethus aridimpressus* and the butterfly *Heteronympha merope merope* in favoured gorges in Wilpena Pound, over 90 miles away from their next main occurrences at Mount Remarkable. (*Heteronympha merope merope* also occurs in favoured gorges in the Elder Range 10 miles west of Wilpena Pound.) A stunted mallee form of *Eucalyptus elaeophora* occurs in the highest 300 feet of the Elder Range (3,700 feet) and as a similar though less stunted patch in the Clare region. Its main occurrence is as large trees on Mt. Remarkable and in Alligator Gorge, 90 miles to the south or 70 miles to north respectively. Both the Elder Range patch and the Clare patch could hardly have survived more aridity than at present exists, nor could the small clumps of only a few tree ferns (*Dicksonia antarctica*) present in Morialta Gorge, and some other isolated localities in South Australia when the white man came. This also applies to the small patch now existent at the Silverband Falls in the Grampians of Victoria.

ERRATUM. On p. 153 of Part 1 of this paper *Lasidiella* should read as *Lasiellidea.*

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